Metallurgist

МЕТАЛЛУРГ

NUMBER 6 1961

METALLURGIST

METALLURGIST is published in translation by the Board of Governors of Acta Metallurgica, with the financial support of the NATIONAL SCIENCE FOUNDATION.

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The translation and production of METALLURGIST are being handled by Consultants Bureau Enterprises, Inc.

Translation Editor:

PROFESSOR BRUCE CHALMERS, *Harvard University*

Acta Metallurgica is an International Journal for the Science of Metals. It is sponsored by the AMERICAN SOCIETY FOR METALS and the AMERICAN INSTITUTE OF MINING, METALLURGICAL, AND PETROLEUM ENGINEERS and is published with the cooperation of the following societies:

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Issued monthly. One volume per annum consisting of 12 issues and containing approximately 50 pages per issue.

Annual subscriptions (which must be paid in advance) are:

To libraries, institutions, and individuals, \$25.00 (£ 9) including postage.

To members of cooperating and sponsoring societies of Acta Metallurgica, \$12.50 (£ 4/10) including postage.

Single issues, \$4.00 (£ 1/8).

Orders should be sent to: BUSINESS MANAGER

ACTA METALLURGICA

122 EAST 55TH ST. · NEW YORK 22, N. Y.

METALLURGIST

A translation of METALLURG, the monthly industrial technical journal of the Ministry of Iron and Steel of the USSR

Translation published November, 1961

No. 6, pp. 247-300 **June, 1961**

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GOOD HEALTH AND SAFE WORKING CONDITIONS FOR METALLURGICAL WORKERS

A. Rudnev

Head of the Labor Protection Department of the Central Committee of the Metallurgical Workers' Trade Union

Translated from Metallurg, No. 6, pp. 1-2, June, 1961

In accordance with the resolutions of the 20th Congress of the CPSU and of the June Plenary Session of the Central Committee of the CPSU (1959) the Metallurgical Industry has built and is building new large blast-furnaces and open-hearth furnaces, rolling mills and other plants equipped with modern means of mechanization and automation for the industrial processes, which not only provide for high efficiency and free thousands of workers from hard manual labor, but also provide for healthful and safe working conditions for the workers.

About 140 million rubles (in terms of new prices) was spent in the last three years, and of this sum 52 million were spent in 1960, on the health of workers and the improvement of working conditions in existing industrial establishments.

The introduction of new techniques and advanced methods, the mechanization and automation of industrial processes, and a higher responsibility of the management and Trade Union organizations for safety and health conditions made it possible to reduce illness and industrial injuries substantially. In the last three years alone, the number of cases of industrial injuries at Metallurgical establishments has been reduced by 41.1%. Thus, in 1960, the reduction amounted to 13.1% compared with 1959; and at the Magnitogorsk Metallurgical Combine it amounted to 24.5% at the Novo-Tula Metallurgical Works – 16.9%, at the Enakievo – 19.3%, at the Petrovsk-Zabaikal – 23.1%, at the Chusovsk – 28.7%. The number of cases of industrial injuries also decreased considerably at several other metallurgical establishments.

In their flight to carry out the historical resolutions of the 21st Congress of the CPSU with regard to the completion of the 7-Year Plan Soviet metallurgists achieved significant successes in the first two years by producing 800,000 tons of pig iron, more than 5 million tons of steel, and about 4 million tons of rolled product and almost 6 million tons of iron ore in excess of the planned quota.

The published results of industrial production for the first quarter of this year indicate that the third year of the 7-Year Plan will be just as successful.

A further improvement in working conditions for metallurgical workers will contribute to a successful fulfillment of the industrial obligations undertaken. However, a check carried out by the Central Committees of the Metallurgical Trade Union has shown that the management of some establishments forget their responsibility for establishing healthful and safe working conditions and forget the fact that the transgression of laws regarding the labor protection, safety conditions and industrial health is incompatible with the high profession of managing Socialist establishments. The Trade Union Committees at those establishments do not make use of the rights accorded to them by legislation regarding control, and they show complacency and unprincipled attitudes, condoning the offenders against legislation.

Cases of industrial injuries actually increased in 1960 compared with 1959 at the following industrial establishments: the Taganrog Metallurgical Works, Orsk-Khalilovo, Alchevsk and some other Works. The "Azovstal'" and the Chelyabinsk Metallurgical Works made a poor start in 1961.

In the resolutions of the 11th May, 1960, the 5th Congress of the Trade Union of Metallurgical Workers made the management and trade union organizations responsible for taking measures aimed at a further improvement in industrial safety and hygiene, for combatting existing shortcomings in this field ruthlessly, for increasing the sense of responsibility for the establishment of safe working conditions at the plants, for taking urgent measures regarding the eliminating of air pollution in towns and settlements near industrial establishments and the prevention of any water

pollution in water reservoirs. The Trade Union Committees undertook to make full use of the rights accorded to them by legislation as regards the supervision and check of compliance with the legislation of working conditions and on general inspection of working conditions in industry.

The Congress considered it essential to put on record that the National Economic Councils have to pay more attention to the improvement of working conditions in industry and to ensure the unconditional fulfillment of all the measures for the improvement of health conditions which were accepted by mutual agreements regarding labor protection; the National Economic Councils should prevent establishments, plants and individual machinery being put into operation, without preliminary inspection and acceptance by technical and health commissions. They should undertake the necessary measures to ensure the provision of a special industrial garment made from specially treated material for industrial establishments, as outlined by standard specifications and conforming with the existing specimen, and should also ensure that every establishment provides facilities for maintenance of special clothes and shoes.

In August, 1960, the Second Plenary Session of the Central Committee of the Trade Union considered the problem of "The status of and the measures aimed at the improvement of labor protection, safety and industrial health at the establishments of the metallurgical industry." In the resolution, passed at this Session, the program for a further improvement in working conditions and for the elimination of industrial injuries and industrial illnesses in the metallurgical Industry was outlined and passed to the management and trade union organizations to be carried out.

However, a check showed that a number of industrial managers did not draw the right conclusions from the resolutions of the Congress and of the Central Committee. Thus, for instance, large industrial plants in the Dnepropetrovsk, Chelyabinsk and Lipetsk National Economic Councils in 1960 were put into operation without technical and health inspection and approval, while there were serious shortcomings with regard to safety and health protection. On the request of the Presidium of the Trade Union Council and the Presidium of the Central Committee of the Trade Union, these shortcomings must now be eliminated without strict time limits. Such irregularities would not exist if the Trade Union Committees at the corresponding establishments as well as the District Committees of the Trade Union made full use of their rights defined by the legislation on the inspection and control of compliance with the legislation when new plants are put into operation, and if the above Committees demanded that the management did not put any plant in which there were any shortcomings with regard to any aspect of industrial safety and health into operation.

Recently, the Central Committee of the Trade Union studied the work of the management and trade union organizations in relation to an improvement in working conditions at the sinter plants of the Yuzhnoi Ore-Beneficiation Combine, the Kamysh-Burunsk Iron Ore Combine, the Blast-Furnace Shops at the Magnitogorsk, Nizhni Tagil, and the Kuznetsk Metallurgical Combines and at the Dzerzhinskii, Alchevsk and Krivoi Rog Metallurgical Works. It was established that no extra expenditure is involved in the elimination of the causes of industrial accidents. It is only necessary to have well organized cooperation of all sections of management and trade union organizations, the right selection and utilization of trained people, an improvement in the industrial discipline and strict and accurate compliance with all the rules about safety at work.

An improvement in industrial hygiene and better working conditions at the plants in question have been obtained mainly by improving production processes, introducing the mechanization and automation of manual operations, improving the prophylactic work of the management and trade union organizations with regard to industrial health and also as a result of some measures aimed at the improvement of health carried out by medical sections at these establishments.

The Presidium of the Central Committee of the Metallurgical Workers' Trade Union considered and approved the studied practices and the measures carried out at these establishments and recommended the management of metallurgical establishments and design organizations to utilize this experience in the design of new shops and works and in the modernization of existing ones.

The Trade Union organizations, together with the industrial management should develop practical proposals with regard to an improvement in working conditions in every shop and should establish a systematic inspection and check on how these proposals are put into practice.

A special role in the establishment of healthy and safe working conditions is to be played by the research and design institutes. Some institutes do not appreciate the significance of this problem for the nation and do not make use of accumulated experience at industrial establishments. An obvious example in this respect are the Yuzhniproruda and Ukrigipromez – the main designers of the YuGOK-2 and of the Krivoi-Rog Metallurgical Works – whose projects have serious defects with regard to working conditions.

The scientific and technical societies and the associations of inventors and innovators can be of great assistance to the management in the work on the improvement of working conditions. At some establishments, they are already helping the management. They should initiate work in the field of labor protection and safety techniques. The Trade Union Committees should establish a control and assist the societies in the development of practical plans designed for an improvement in working conditions.

The management of industrial establishments and the leaders of industrial departments of National Economic Councils must eliminate the existing shortcomings in industrial safety as soon as possible; under no circumstances, must they permit new concerns, shops or individual plants being put into operation if there are even slight shortcomings with regard to safety or health protection, until permission is given after a technical and health inspection.

The Trade Union Committees should improve their work in the field of industrial health and make more demands on the management, as well as improve the health protection by ensuring strict compliance with all the requirements specified by the legislation. It is essential to give more publicity to tested practices and experience.

Combined efforts of the management and trade union organizations under the guidance of Party organizations will ensure good results before the 22nd Congress of the CPSU. There is no doubt that the instructions of the Party will be carried out. Soviet metallurgists will have healthful and safe working conditions.

THE BLOWING-IN OF BLAST-FURNACES OF 1719 m^3 VOLUME

(BASED ON THE REPORTS OF AN INTER-WORKS COURSE)

E. V. Kochinev, B. N. Starshinov, V. K. Kornev,
and Yu. A. Popov

Gipromez, Ukrainian Institute of Metals, Nizhni Tagil Metallurgical Combine
and Chelyabinsk Metallurgical Works
Translated from Metallurg, No. 6, pp. 3-7, June, 1961

The construction of large blast-furnaces has been established on the basis of the use of the equipment of blast-furnaces of 1386 m^3 volume. An increase in the working volume of the furnace with a small increase in capital expenditure will make it possible to increase the output of pig iron per furnace, reduce capital investment per 1 m^3 of working volume of the furnace and reduce the cost of pig iron produced in large furnaces as well as increase the operating efficiency per worker.

On the other hand, the increase in the working volume of the furnace has assisted in the full utilization of the capacity of the equipment of blast-furnaces of 1386 m^3 volume and as a result of this fact some parts of the equipment may become limiting factors in the operation of large-volume blast-furnaces.

The study of experience on the operation of blast-furnaces of 1719 m^3 volume will make it possible to determine the bottlenecks in the operation of these furnaces with the object of eliminating these bottlenecks in the design of large-volume blast-furnaces.

The first 1719 m^3 blast-furnace was blown-in at the Krivoi-Rog Metallurgical Works and then similar furnaces were blown-in at the Chelyabinsk, Il'Ich, "Azovstal'" and some other Works.

The Drying of Blast-Furnaces

Since there are no new standard instructions as regards drying, various procedures for drying the blast-furnaces have been used at different Works.

Thus, at the "Azovstal'" Works and the Nizhni Tagil Combine the furnaces were dried with coke-oven gas fed from the leader to the blast-furnace bottom by a 3-inch gas pipe arranged in the form of a cross (at "Azovstal'") or by 2 concentric gas pipes of 60 mm diameter (at the Nizhni Tagil Metallurgical Combine). Compressed air at 3 atm gauge pressure was supplied by corresponding parallel air lines (cross-shaped pipes of 3-4 inches diameter at the "Azovstal'" Works, and a ring pipe of 60 mm diameter located between the two gas lines at the Nizhni Tagil Metallurgical Combine).

At the "Azovstal'" Works, before the coke-oven gas was fired, a wood fire was maintained at the bottom of the blast-furnace for 24 hours in order to dry the refractory lining, and at the Nizhni Tagil Metallurgical Combine a wood fire was made up only with the object of ensuring the initial firing of the coke oven gas.

At the "Azovstal'" Works the wood fire was maintained with air and then the coke-oven gas was fed in gradually; at the Nizhni Tagil Metallurgical Combine it is considered that the wood fire should be assisted initially with a small quantity of the gas and then, after the wood starts burning, the gas rate should be increased and air is introduced.

According to the procedure accepted at the Il'Ich Works, the drying of the refractory lining is carried out for the first two days by maintaining the wood fire on the bottom of the furnace. Afterwards, the furnace is dried with hot air charged by an air fan through a hot air stove.

At the Krivoi-Rog Works the furnaces are dried by electric heating (9 days) and then with hot air (3 days).

The temperature in the furnace is controlled by the temperature of the gas-air mixture in the gas offtakes ("Azovstal'"), by the temperature of the hot blast charged into the furnace (Il'ich Works) or by the temperature in the vicinity of the slag notch (Krivoi-Rog Works).

At the "Azovstal'" Works it is considered that the increase in the temperature of the gas in the gas offtakes should not exceed 5°C per hour, starting from 50°C during the drying of the furnace with gas, and at the Krivoi-Rog Works the increase rate should not exceed 50°C for every two 24-hr days etc.

During the drying with hot air at the Il'ich Works the air temperature is gradually increased from 100°C, after drying with the wood fire, to 500°C; at the Krivoi-Rog Works the air temperature is 350°C. Drying by electric heating at the Krivoi-Rog is carried out at a temperature up to 250°C in the vicinity of the slag notch on the 10th day of the drying. At the "Azovstal'" the maximum gas temperature of the blast-furnace top is 400°C.

TABLE 1. The Blowing-in Charge of the Blast-Furnace

Works	No. of rounds	Weight, ton							Ore burden, tons/ton	
		coke	iron ore	quartz-lite	bricks	blast-furnace slag	manganese ore	limestone	ore only	ore and fluxes
Il'ich	58	580	316.5	—	120	—	11.7	214.8	0.773	1.143
"Azovstal'"	63	630	130.65	—	—	144	—	125.25	0.436	0.635
Krivoi-Rog	82	615	353.8	—	—	—	10	360	0.592	1.177
Nizhni Tagil	92	704	398.5	84.8	—	—	—	258.6	0.687	1.054
Chelyabinsk	79	632	400	50.0	—	118.3	—	173.6	0.899	1.174

All the methods described above should, if followed strictly, ensure a satisfactory drying of the blast-furnace. The drying of blast-furnaces of 1719 m^3, which was carried out very carefully during the start of the operation, was done generally in accordance with the methods described above. At the Chelyabinsk Works the furnace was fired with the coke-oven gas by methods similar to those applied at the Nizhni Tagil Metallurgical Combine, at the "Azvostal'" Works the drying was carried out at first with coke-oven gas and then with hot blast up to a temperature of 600°C; at the Il'ich Works the temperature of the hot blast was also 600°C.

The total duration of the drying operation in some cases was determined by the date on which the furnaces had to be put into operation and not by the requirements of the drying process and that should not have been allowed. As a result, the drying of the blast-furnace of 1719 m^3 was not satisfactory.

In addition, at all the Works mentioned it was essential to pay more attention to the control of the drying operation and to ensure an uninterrupted supply of the gas which should be at a minimum pressure of 150-200 mm of water. During every drying operation an accurate record of the procedure should be entered in the furnace logbook.

The drying of the furnace with coke-oven gas should take 7-10 days and with hot blast 10-12 days.

The best drying of the blast-furnace process with coke-oven gas was carried out at the Nizhni Tagil Metallurgical Combine, and with hot blast at the "Azovstal'" and Il'ich Works.

Charging the Blast-Furnace

The operating instructions at the Il'ich Works provide for covering the blast-furnace bottom up to 100-150 mm thick with pig iron scrap prior to the introduction of the charge; placing a bed of logs up to the height of the air duct; protecting the lining of the bosh and the mantle with sleepers; and inserting firebrick sleeves in the tuyeres in order to reduce the diameter to 100 mm. The start-up charge should extend to a height of 1.5 m.

In practice, in the blast-furnace at that Works before the blowing-in operation, the hearth of the blast-furnace was charged with wood up to the level of the slag notches only, the wood was also piled in front of the air tuyeres; the bosh and the mantle were not protected by the sleepers.

In accordance with the instruction at the Krivoi-Rog Works a platform was erected up to the height of the tuyeres. On this platform dry wood was piled up to a height of 1 m, and 40 tons of pig iron scrap was charged on the blast-furnace bottom. The bosh was protected by wood logs. The charge material was piled up to a height of 0.5 m before the blowing-in operation.

At the Nizhni Tagil Metallurgical Combine the blast-furnace hearth was not filled with wood before the charging, but the tuyeres were protected with logs and planks. The furnace was charged up to the stock level of 2 m. The furnace at the Chelyabinsk Metallurgical Works was charged in the same way.

At all these Works, a steel tube of 75-100 mm diameter was introduced to a depth of 2-4 m into the hearth of the furnace through the pig-iron tapping hole before the introduction of the charge.

It is desirable at all the furnaces to load pig iron scrap on to the blast-furnace bottom and lay a timber platform in the blast-furnace hearth or fill it with dry wood before the introduction of the charging materials. The tuyere nozzles should be withdrawn during the charging.

The blowing-in of the furnace should be started only after the completion of the charging operation, but this rule was not always observed (e.g., at the Il'ich Works).

Before the rounds with the ore were introduced; the following quantities of coke were charged into the blast-furnace; 150 tons at the "Azovstal'" Works, 80 tons at the Il'ich Works, 75 tons at the Krivoi-Rog Works, 234 tons at the Nizhni Tagil Metallurgical Combine and 128 tons at the Chelyabinsk Works. It is recommended that before the charge is introduced the furnace should be filled with coke up to the level of the mantle.

It is seen from Table 2 that the regime of the blowing-in operation was not the same at every furnace. The Il'ich Works and the Nizhni Tagil Metallurgical Combine used the smallest quantity and the lowest temperature of the blast. This factor contributed to the fact that the first batch of pig iron at the Il'ich Works was at a faintly low temperature.

TABLE 2. Operating Conditions for the Blowing-In Operation

Works	Blast			Tuyere diam., mm
	quantity, m^3/min	temp., °C	pressure, atm gauge	
"Azovstal'"	–	750	1.3	180
Il'ich	2000	600	0.9	180
Krivoi Rog	–	840	0.4	180
Nizhni Tagil	1950	650	0.7	160
Chelyabinsk	1700	700	0.6	200

During the first day of operation the blast to the above furnaces was maintained at 730-850°C at a rate of 1180-1880 m^3/min. After the blowing-in, the ore burden was gradually increased until the required pig iron composition was obtained.

The first batch of pig iron was tapped as follows: at the "Azovstal'" Works 14 hours after the blowing-in; at the Il'ich Works 26 hours 30 min; at the Krivoi-Rog Works 20 hours 45 minutes; at the Nizhni Tagil Metallurgical Combine 31 hours and at the Chusovsk Works 28 hours. At the Nizhni Tagil Combine there was only a trace of pig iron in the first tapping, at the "Azovstal'" Works and Il'ich Works there were only 9 and 17 tons of pig iron, respectively, but at the Krivoi-Rog Works the weight of pig iron in the first tapping constituted 51 tons and at the Chusovsk Works it constituted 160 tons. The small quantities of pig iron in the first tapping at the Nizhni Tagil Combine and "Azovstal'" and Il'ich Works are explained by the light burden in the first charge at the "Azovstal'" Works, by the poor quality of the iron ore in the first charge at the Il'ich and the "Azovstal'" blast-furnaces and by the low rate of blast at the Nizhni Tagil Combine during the first two days after the blowing-in.

The tapping holes were most easily opened at the Il'ich Works and the Krivoi-Rog Works where the hearth was filled with timber before the blast-furnace was charged. At the Nizhni Tagil Combine and the Chelyabinsk Works the tapping hole could be opened only after oxygen lancing and it required a few dozens of oxygen cylinders.

At the "Azovstal'" Works there were no difficulties with the blowing-in of the furnace and the tapping of the first pig iron was 1.8%.

Since the first charge in the blast-furnace at the Il'ich Works was calculated on the basis of a lower coke consumption than at the "Azovstal'" Works, the first pig iron obtained was at a very low temperature (the silicon content was 0.6%). After this tapping, 11 rounds were charged without the ore, and the ore burden was reduced. This resulted in an overheating of the furnace; the silicon content in some tappings increased to 9-10% and the temperature of the furnace was not steady.

At the Krivoi-Rog Works there were not difficulties with the blowing-in and the tapping of the first pig iron, the furnace operated at a steady temperature but was blow in at a high temperature (the silicon content was 5-6%).

At the Nizhni Tagil Combine, the furnace operated at a reduced blast rate during the first two days because of the difficulties in opening the tapping hole. It was opened only after prolonged oxygen lancing. This obviously was caused by the solidification of pig iron and slag in the coke layer on the furnace bottom because of the inadequate

temperature of the hearth. Due to delays in tapping the products and to the operation of the furnace during this period at a low rate and at a blast temperature of 900°C, the silicon content in the pig iron during this period was very high (10.1-11.4%). The thermal condition of the hearth was adjusted by lowering the temperature of the blast to 600°C, and increasing the ore burden to 2.15 tons/ton.

At the Chelyabinsk Works, too, the first tapping of the pig iron was carried out after a prolonged oxygen lancing of the tapping hole. The furnace was at a low temperature during the blowing-in period; the products were not adequately heated and not sufficiently mobile although the silicon content in the first batch of pig iron was 2.5%. The content of FeO in the slag was up to 1.67%. To heat up the furnace the blast temperature was increased to 950°C, the ore in the round was reduced by 1 ton; and that resulted in an excessive overheating and an increase of up to 9.0% in the silicon content in the pig iron. Therefore, the temperature of the blast was subsequently reduced to 700°C and the ore charge was restored.

The basicity of the slag at the furnace varied considerably. During the first three days of operation it was as follows: 1.14-1.30 at the "Azovstal'", 1.13-1.54 at the Il'ich, 1.24-1.57 at the Krivoi-Rog, 1.09-1.26 at the Nizhni Tagil and 0.7-1.0 at the Chelyabinsk Works. The basicity of the slag at the Chelyabinsk Works was lower than it should have been, and at the other Works it was higher. This applies in particular to the Il'ich and the Krivoi-Rog Works. The optimum slag basicity ($CaO : SiO_2$) should be within the range of 1.15-1.25.

An analysis of the charge operation and of the blowing-in of the furnaces shows that for a better heating of the hearth and a rapid opening of the iron notch it is advisable to charge wood in the hearth or lay a platform of timber. If that is done then the first products of the smelting operations will not cool down and will not become less mobile when they fall on the cold coke which lies at the blast-furnace bottom, but will remain fluid since the coke will be hot (heated by the burning wood and timber).

TABLE 3. Chemical Composition of First Pig Iron and Slag, %

Works	Pig iron			Slag		
	Si	Mn	S	SiO_2	CaO	$\frac{CaO}{SiO_2}$
"Azovstal'"	1.78	0.17	0.278	37.4	44.6	1.27
Il'ich	0.64	0.18	0.315	32.6	50.4	1.54
Krivoi Rog	4.81	0.33	0.060	37.4	46.3	1.24
Nizhni Tagil	11.00	1.43	0.010	35.4	44.8	1.27
Chelyabinsk	2.54	0.43	0.118	49.9	34.8	0.70

In order to obtain the first slags with the required basicity and adequate desulfurizing power it is advisable to add 1 ton of limestone to every fifth round of coke without ore, the coke round being equal to 8 tons.

At all the Works there were some troubles which interferred with the normal operation of the furnaces in the first days after the blowing-in. Especially extensive difficulties were encountered at the blast-furnace of the Il'ich Works because at the time of the blowing-in no suitable arrangements had been made for a continuous disposal of the products.

During the initial period of operation at the Krivoi-Rog Works the running of the furnace was upset because of a breakdown of the bell hoist, the scale cars and the electric gun (there was no spare electric clay gun at the Works). As a result of the breakdown of the clay gun, the clay for plugging the iron notch had to be prepaired with a higher moisture content and therefore it was not always possible to dry the iron notch satisfactorily prior to the pig iron tapping; the length of the notch was not adequate; the hearth of the furnace was not carefully blown through for each tapping; the the blast pressure had to be reduced to 1.0 atm during the plugging of the iron notch and this interferred with the smooth running of the blast-furnace.

At the "Azovstal'" Works leaks occurred in the connection flanges of the tuyere bends so that the temperature could not be increased satisfactorily and the furnace had to be shut down for the elimination of leaks.

During the initial period of operation at the Nizhni Tagil Combine a blowout occurred at the point where the instrument for measuring the static pressures of the gases was mounted. The failure of the shaft was caused by design defects in the measuring instrument.

Interruptions of the furnace operation at the Chelyabinsk Works were caused by the inadequate pressure of the clay gun, disruptions in the operation of the charging equipment and in the slime catcher downstream of the scrubber. As a result of the furnace operation with an overloaded central part, the air tuyeres as well as the frame of the No. 2 slag notch burned through.

There were interruptions in the furnace operations at all these Works because the schedule of pig iron tapping and slag running off was not adhered to owing to the shortage of hot metal ladles and slag ladles.

Any delays, interruptions or difficulties during the first days of furnace operation after the blowing-in cause a nonuniform temperature in the furnace, result in the solidification of the products in the hearth, or an excessive increase in the temperature of the products and in the silicon content of the pig iron. Any of these phenomena have negative effects on the running of the furnace. Therefore, prior to the blowing-in of the furnace it is essential to check all the charging equipment, instrumentation and controlling equipment, the clay gun, the slag stoppers, etc., and to ensure that all the furnaces to be blown in are fully provided with means for the disposal of products, and also to ensure that there is a demand for the pig iron in the steel-melting and casting shops, or that the pig iron can be cast on the casting machines.

The charge for the blowing-in operation should be calculated on the basis of a small quantity of slag so that the lining of the new furnace is not eroded with slag. No addition of blast-furnace slag to the blast-furnace charge should be allowed as was the case at the "Azovstal'" and Chelyabinsk Works. During the first days of the blowing-in there is no need for new furnaces to operate at a high slag yield (1.5 tons/ton or more) as was the case at the Il'ich Works.

The majority of the new blast-furnaces of 1719 m^3 volume were blown-in at too high a temperature, except for the blast-furnaces at the "Azovstal'" and Il'ich Works. Therefore, the silicon content in the pig iron during the first tapping was up to 9-11.5%.

The blast-furnace at the Il'ich Works was blown-in at a low temperature and the silicon content in the first pig iron was only 0.6%, but later on the furnace was allowed to get overheated. In addition, the temperature in the furnace during the first days of the blowing-in was very unsteady for various reasons, and therefore the silicon content in the pig iron varied from 5 to 10% at the Il'ich and Nizhni Tagil and from 2.5 to 9.0% at the Chelyabinsk Works. At the Krivoi-Rog blast-furnace the silicon content remained constant but it was very high (4.3-6.5%). Silicon content in the first pig iron tapping at the "Azovstal'" Works was normal (1.8%) but later it increased to 3.0-4.6%.

The following conditions must be observed in order to protect the lining of the new furnaces:

a) Pig iron composition: 2-3% silicon, 0.3-0.8 manganese, and maximum 0.1% sulfur;

b) The quantity of ore rounds for the blowing-in operation should not be more than 3-5;

c) The coke consumption in the total charge during the blowing-in operation should be 2.5-3.0 tons per ton of pig iron (in the last round the coke should not exceed 1.2-1.3 tons per ton of pig iron);

d) The first ore round should be charged in the upper part of the bosh;

e) The quantity of slag should be as small as possible; no blast-furnace or open-hearth furnace slags should be allowed in the blast-furnace charge during the blowing-in operation;

f) The basicity of the slag, $CaO:SiO_2$, should be within the range of 1.15-1.25;

g) The furnace should be blown-in with tuyeres of normal diameter; during the initial period, clay sleeves should be inserted into the tuyeres with the object of removing the flame from the walls and increasing the pressure of the blast;

h) The iron notch should be kept open until pig iron splashes appear through a tube inserted into the iron notch before the beginning of the charging operation; as soon as gas begins to come out through the tube it should be ignited;

i) The temperature of the blast should be maintained initially at not less than 600°C, and then it should be adjusted depending on the temperature of the hearth and the running of the furnace.

ERRORS IN GAS FLOW CONTROL AND BURDEN DISTRIBUTION

Metallurgist No. 8 1960 contained an article on the above subject by A. N. Chechuro and I. L. Kolesnik. We publish here comments on this article

Yu. A. Orlov

Kushva Metallurgical Works

Translated from Metallurg, No. 6, pp. 7-9, June, 1961

In their article, A. N. Chechuro and I. L. Kolesnik maintain that the existing methods of controlling the gas stream and the distribution of materials in blast-furnaces are not correct and they propose entirely new methods. Two-months operation of four blast-furnaces at the Dzershinskii Works when they were controlled "from above" has confirmed that the methods these authors suggest are correct.

However, the methods of controlling blast-furnaces proposed by A. N. Chechuro and I. L. Kolesnik cannot be accepted without qualification. Justifying their methods of blast-furnace control the authors assume far-fetched simplifications in the evaluation of the causes of temperature variation in peripheral gases. They explain this temperature variation only by the variation in the flow rate of gases and materials.

The statement that with an increased rate of descent of the charge the utilization of the physical energy of gases improves is indisputable. But the absolute value of the temperature of the peripheral gases depends not only on the velocity of descent of the charge but also on a number of various other factors. One must determine these factors correctly in order to be in a position to control them.

Let us consider some practical cases.

1. The blast-furnace operates uniformly over its entire cross section. The rate of descent of the charge on the shaft periphery is uniform but the stock indicators show a constant slope of the stock line. In this case the readings of the thermocouples installed below the stock level for measuring the temperature of the peripheral gases will vary. A low temperature will correspond to the low side of the stock and vice versa.

In this case an additional number of rounds should be added on the side on which the stock level is lower by changing the operation of the revolving distributor appropriately.

2. As a result of a nonuniform distribution of the blast over the tuyeres, or an irregular operation of the charging equipment, etc., the descent of the charge is one sided. In this case the temperature at the periphery will be lower on the side on which the charge descends more rapidly and therefore the methods proposed by A. N. Chechuro and I. L. Kolesnik are applicable; i.e., for a better utilization of the gas stream a few ore rounds are charged into the region where the blast-furnace operates more intensively.

The authors describe a case similar to the two cases mentioned above, but their explanations are not convincing because one cannot conclude whether the furnace was operating on one side or was it simply a case of a sloping stock level.

One cannot agree with the recommendations of A. N. Chechuro and I. L. Kolesnik regarding the methods of preventing the channelling of the gases. It was found in practice that the temperature of the gases in the channelling part is always higher than in that part of the stock where the gas flow rate is less intense, since the localization of the gas stream does not promote a rapid descent of the stock and, consequently, does not contribute to an improvement in the utilization of the thermal energy of the gases in the channelling part of the stock.

The appearance of lumps near the tuyeres not ready for the smelting does not indicate at all that the stock descends rapidly in the region of channelling. Heavy particles of ore and limestone will obviously fall very rapidly into the lower part of the furnace if they get into the channel where coke can be in a fluidlike state.

Thus, the mistaken views of the authors led to erroneous conclusions. The ridge of the ore should be located not in the low temperature zone, but, on the contrary, in the high temperature zone. If this measure is not adequate it is necessary to stop the channelling by starting the "snorting" of the furnace and at the same time starting to lighten the burden on the periphery. If the stock settles too much it is advisable to charge a few rounds without ore.

It is difficult to find a complete explanation of the following statement: "... A high peripheral temperature indicates the development of a central gas flow and poor utilization of the physical energy of the gas moving along the periphery."

Length of operation, hr	Method of charging	Regime of the rotating distributor	Temperature, °C		Temperature difference, °C
			at point 2	at point 5	
48	One round – COOOOCC↓ Two rounds – OOOOCC↓	6 consecutive positions	660	904	244
16	The same	+ 60° position doubled - 120° position omitted	615	915	310
8	The same	6 consecutive positions	596	803	213
20	The same	+ 60° position omitted - 120° position doubled	700	768	68
16	One round $C_1O_6C_2$↓ The same, O_6C_4↓	6 consecutive positions	910	935	25

The temperature of the periphery during a central flow of gases will be high if the descent of the charge in a narrow peripheral annulus is retarded as a result of rapid additional charging. In this case the heat-exchange processes in the narrow peripheral annulus approach equilibrium very rapidly since the thermal conductivity of ore is approximately seven times higher then the thermal conductivity of coke. This process is also facilitated by the heat of exothermic reactions. In practice, however, it was found that the temperature of the peripheral gases is higher where there is a higher flow rate of the gases.

It was found during the operation of the blast-furnaces which have a bosh inclination angle near to 90°, that owing to the specific features of the contour of these furnaces, there is a tendency towards intensive peripheral gas flow. The maximum quantity of the gases passes near the furnace walls, and the descent of the charge is also most rapid near the walls. However, the region of high temperatures is also at a high level in the furnace. Thus, for instance at blast-furnace No. 1 of the Kushva Metallurgical Works the temperature of the peripheral gases at 0.5 m below the guard plates was up to 1000°C. When the descent of the charge was slow and the periphery of the shaft was lightened as a result of the application of reversed rounds, a rapid increase in the peripheral temperature took place. Therefore the statement of these authors cannot be true for every case in blast-furnace practice.

The following experiment was carried out at the Kushva Works with the object of testing the conclusions of the authors. At furnace No. 1, when the temperature fell at Point 2 (see table) which corresponds to the + 60° position of the rotating distributor, and increased at Point 5 (-120°) the regime of the rotating distributor was changed. The temperature difference increased by 66°. When, however, the furnace was charged with all six positions of the rotating distributor in normal sequence, and 8 hours later the charging procedure was changed so that the + 60° position of the distributor was omitted, the temperature difference was reduced to 68°. An even more uniform condition of the peripheral gases was achieved when increased round was introduced. It follows that in this case the application of the new method of furnace operation control was not suitable since there were indications of channelling in the furnace.

In order to investigate the possible application of the methods proposed by A. N. Chechuro and I. L. Kolesnik for controlling the gas flow in blast-furnaces it is definitely essential to carry out more experiments.

THE EROSION OF REFRACTORY LINING IN BLAST-FURNACES OF 1719 m^3 VOLUME

I. M. Galemin and N. K. Fridman

Translated from Metallurg, No. 6, pp. 9-12, June, 1961

The 1719 m^3 blast-furnace , blown in on October 15, 1958, was in operation for 1 year and 10 months and was shut down for a second-class major overhaul in connection with the breakdown of coolers of the bosh and shaft and complete erosion of the lining in the lower half of the shaft. During all this period (except the time of blowing-in) the product was open-hearth pig iron containing 0.8-0.9% silicon and 0.8-1.1% manganese. The technical and economic indices of the operation of the furnace were satisfactory.

The shaft of the furnace was laid with Chasov-Yar firebrick and was cooled by vertical plate coolers with built-in brickwork; when the coolers became unusable and ineffective, the blast-furnace shell had to be sprayed from the outside. The bosh and the tuyere area of the hearth were lined with firebrick from the Semiluki Works. Carbon and graphite blocks were used in the part of the hearth containing hot metal below the slag notches, as well as on the outside and below the hearth bottom. The central part of the hearth bottom was lined with high-alumina bricks (approximately 62-65% alumina). All the refractory materials conformed with the accepted standards.

Just over two months after the blowing-in of the furnace, the coolers of the bosh began to break down, and after 8 months, the coolers of the shaft. Since it was difficult to detect the defective coolers quickly, the furnace received large quantities of water which sometimes flowed at a high rate of the iron notch as well as through openings in the shell of the lower part of the furnace. The inspection of the shaft 8 months after the start of operations established that a substantial part of the lining in the lower half of this part of the furnace was missing and in place of this lining a hardened slag layer 150-250 mm thick formed on the wall of the furnace. Subsequently, the coolers of the shaft broke down rapidly and after 16 months it became necessary to spray the furnace shell intensively with water.

After the furnace was blown-out it was carefully inspected. Figure 1 shows the conditions of the furnace lining.

In the upper half of the shaft the lining was preserved since it was supported on the upper row of vertical coolers. 5-6 m below the protective plates of the blast-furnace top the erosion of the lining was quite insignificant. The brick facing the center of the furnace were covered with a 10-15 m crust which had a smooth surface; the composition of the crust differed little from the composition of the remainder of the brick. In the joints between the bricks, small deposits of crystalline zincite which extended to 250-300 m below the surface of the brick (only in the joints) were detected. In general, the brick was in good condition without cracks or deposits of sooty carbon. The brickwork was very strong and was removed only after several blastings. It is interesting to note that even after the blasting and knocking down of the remaining brickwork under the guard plates at the furnace top,there still remained an 1100 mm high layer of brickwork supported on the framework of the gas offtake equipment and the tubes of the thermocouples. This fact proves again that supports prevent the brickwork from breaking down.

Below the described brickwork down to the level of the 7th row of coolers the bricks underwent considerable transformations, they had many transverse cracks and were saturated with sooty carbon and zincite which was found only in the cracks; where there were no cracks the zincite did not penetrate the body of the brick.

In the region of the mantle a very thin layer of brickwork, saturated with sooty carbon and zincite, was preserved. The carbon filling between the brickwork and the coolers was in good condition. The slag incrustation adhering to the coolers in the lower part of the shaft and to the remaining brickwork near the mantle contained approximately 50-60% carbon, up to 5-10% iron, approximately 0.5-2.5 zinc (in the form of zincite) and also a significant quantity of alkali (10-15%). The composition of the slag incrustation in the bosh was approximately the same. The slag incrustation in the bosh constituted one single monolith with the incrustation above the mantle. Porous blocks of reduced and carbonized iron constituted the core of the crustation monolith. In addition to pure iron, in some parts of these blocks there was pig iron with various contents of silicon, and lumps of coke bound together with slag could be found. Some lumps of lime (10-40 mm in cross section) containing 0.25-0.35% sulfur were also found among the coke.

No lining remained in the region of the tuyeres and above the frame of the air tuyeres; an incrustation (380-450 mm), which was the continuation of the incrustation of the bosh, adhered to the coolers.

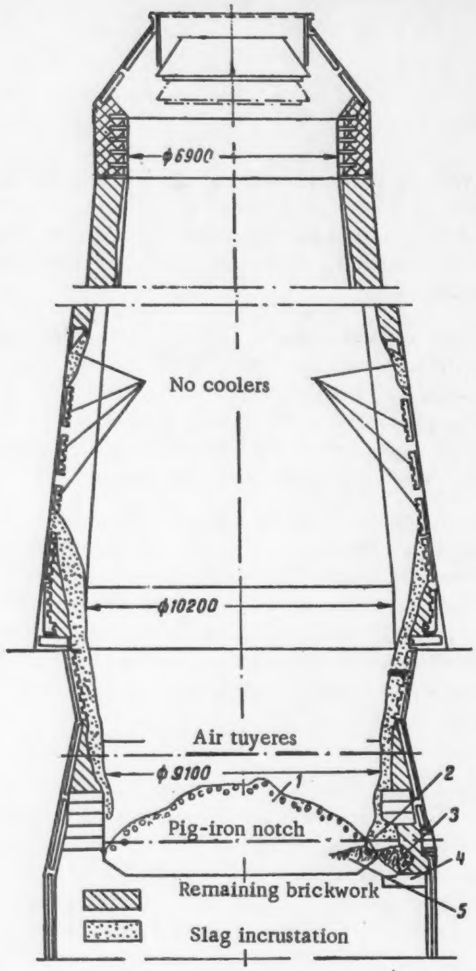


Fig. 1. Condition of the lining after the furnace was blown out in August, 1960. 1) Coke; 2) notch clay and coke; 3) metal, coke, and notch clay; 4) pig iron in eroded block; 5) "skull."

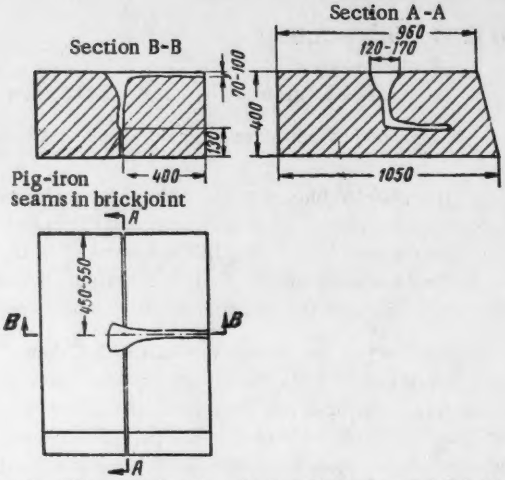


Fig. 2. Diagram showing the location of metal "skulls" in damaged carbon blocks.

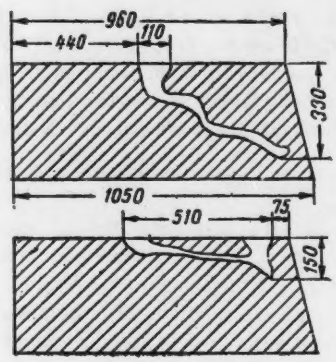


Fig. 3. Type of damage in the side walls of the carbon blocks of the hearth.

Below the air tuyeres the brickwork was preserved in good condition and was 550-600 mm thick. A 200-300 mm thick layer of dense incrustation of stony appearance adhered to the brickwork. The incrustation also extended below the ceramic brickwork in the region of the two upper rows of carbon blocks of the hearth but was not adhering to them. Under the stony incrustation there was a layer of brittle carbon incrustation consisting of particles of coke and dust embedded in slag.

The blocks in the hearth were well preserved (their length was reduced only by 5-7 mm), but their surface on the inside of the furnace was ground and became somewhat wavy in the longitudinal direction indicating a certain erosion. It was found that the penetration of metal inside the block was insignificant (to a depth of 10-15 mm from the working surface).

On the surface of the upper row of the carbon blocks in the hearth, where the blocks were next to the firebrick and the slag incrustation, metal "skulls" penetrating the bulk of the blocks were found in 19 places (Fig. 2). All of them stretched across the blocks and were located 400-500 mm away from the working face of the blocks (Fig. 3). No "skulls" were found under the firebricks. Metal penetrated to the same depth in the joints between the blocks. The thickness of the metal plates removed from the block joints was 0.5-2.5 mm. No mortar was found in the joints.

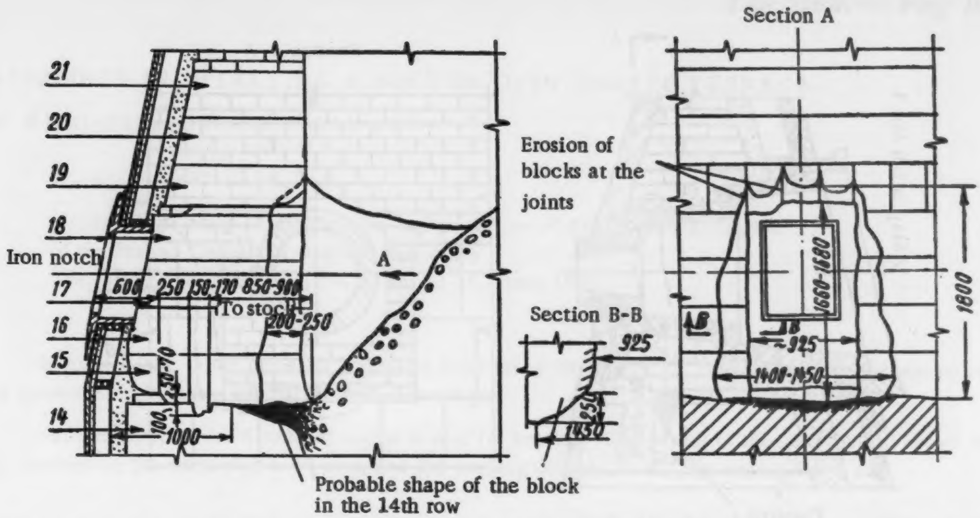


Fig. 4. Erosion of carbon blocks in the region of the iron notch. The figures denote the number of rows.

Various channels were found on the side walls of the blocks (illustrated in Fig. 3). It can be assumed that the water from the damaged coolers penetrated inside and reacted with the carbon blocks. Thus, crevasses were formed and these were subsequently filled with metal (from the furnace) which penetrated the joints between the blocks. The fact that the blocks were primarily damaged by the action of the water can be surmised from the presence of void channels not filled with metal. The water penetrated to the blocks through eroded crevasses and through gaps between the brickwork and the slag incrustation as well as through gaps in the joints between the blocks. The second half of the block, i.e., that one which faced the shell of the furnace, was undamaged as a result of the effect of the coolers, enhanced in this case by the good thermal conductivity of the blocks themselves.

In the region of the iron notch the carbon blocks were eroded on the ends facing the inside of the furnace (Fig. 4). The blocks in the lower part (14th row) were subject to exceptionally severe erosion. The refractory brickwork made of Semiluki firebrick was preserved in the region of the iron notch and remained in a good condition, but its thickness was significantly reduced in the lower part of the iron notch surround (Fig. 5). At a level 750 mm below the center line of the iron notch, the thickness of the brickwork together with the filling constituted only 400 mm.

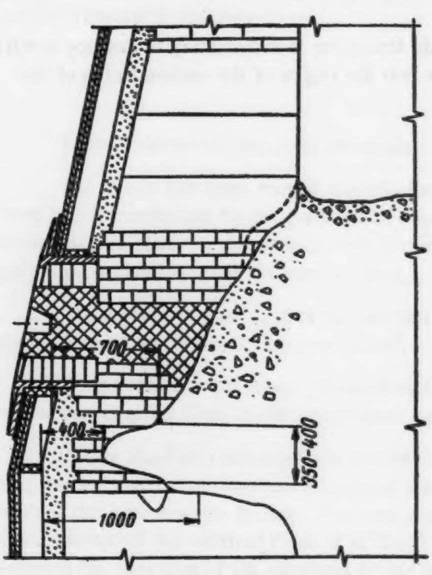


Fig. 5. Condition of the brickwork in the region of the iron notch when the furnace was blown out.

In the blocks on the 14th row there was a 905 mm longitudinal crack (over the whole of the block structure), filled with pig iron. The pig iron entered this crack through the erosion holes formed in the side walls of the block in the 15th, 16th, and 17th rows. On the left of the crack (facing the inside of the furnace) there was a void in the blocks over a length of approximately 1600 mm. One should assume that this void was also formed as a result of the penetration of water into the region of the carbon blocks. The surface in all the voids was friable; a layer 20-30 mm thick crumbled off freely. Even more extensive damage was caused by water in the blocks of the 18th-25th rows in the region of the slag notches (Fig. 6).

On the basis of the operation of the furnace the following conclusions can be drawn.

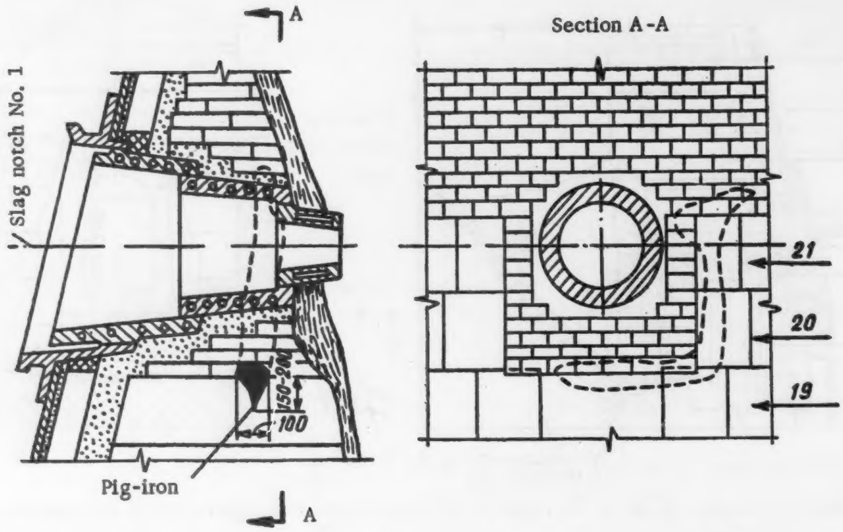


Fig. 6. Damage to the carbon blocks in the region of No. 1 slag notch. The figures denote the numbers of the rows.

When the shaft is cooled with vertical plate coolers there is no reliable support for the brickwork and, in conjunction with the effect of other factors, the brickwork breaks down rapidly. The importance of the support for the brickwork is seen from the condition of the brickwork in the upper part of the furnace.

The penetration of water to the carbon blocks causes a substantial erosion of the block. The voids caused by the erosion are subsequently filled with metal. Especially extensive damage to the blocks in the region of the iron notch is explained by the penetration of water from the damaged cooler into the notch opening. In the region of the slag notches the blocks were extensively eroded in connection with the ingress of water from the burnt-through cooling equipment.

Carbon lining for the bottom of the hearth is better than ceramic lining, but it is necessary to develop a reliable framing for the notch opening and to prevent the penetration of water into the region of the carbon lining of the hearth.

EXPERIENCE IN OPERATING A 400 TON OPEN-HEARTH FURNACE ON HIGH-PRESSURE NATURAL GAS

G. A. Podol'skaya

(From "Information Leaflet" of the Central Bureau of Technical Information of the Stalino Council of National Economy)
Translated from Metallurg, No. 6, pp. 13-16, June, 1961

In April, 1960, in the course of a general overhaul, a 350 ton tilting open-hearth furnace was reconstructed and converted for heating by high-pressure natural gas.

Natural gas from the Krasnodar region is used for heating. The layout of the gas supply is shown in Fig. 1. The pressure in the main pipe is 10 atm, and the working pressure at the port ends is 8.5-9 atm.

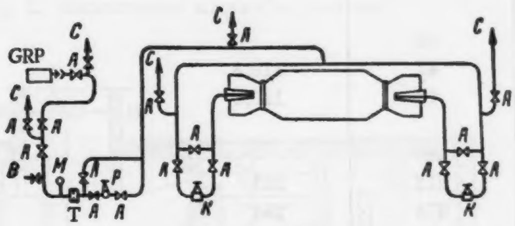


Fig. 1. Layout of gas supply to open-hearth furnace: A) Valves; B) connection for steam blowthrough of gas pipeline; M) pressure gauge; P and K) regulating and cut-off valves; C) bleeders.

Carburetion of the flame is effected by means of coal tar with a net calorific value of 8850 kcal/kg. The pressure of the tar at the burner is 3-4 atm and its temperature is 50-80°C.

The design provided for atomization of the liquid fuel by superheated steam at a pressure of 7-9.5 atm and superheat temperature 300-340°C. As in all the furnaces of the shop, oxygen is used both in the flame and for blowing the bath.

Conversion to heating by natural gas resulted in the replacement of the three-flue port end by a single-flue end; the length of each port end was reduced by 2705 mm, resulting in an increase in length of the working space. With an insignificant increase in the width of the bath, this enabled the area of the hearth to be increased by 36.5 m^2 within the existing dimensions of the shop.

Table 1 shows the principal particulars of the furnace before and after reconstruction.

The burner has been moved towards the furnace by 3310 mm and intersects the vertical flue. To protect it from being overheated by the products of combustion passing round it on all sides, the burner is contained in a water-cooled jacket lined on the outside with chrome-magnesite brick 230 mm thick. The jacket and its lining are supported on arches bridging the vertical flue.

The cross-sectional area of the air port is 5.1 m^2, and the angle of slope of the burner is 12°. The cross-sectional area of the vertical flue was 8.8 m^2.

During the first hot repair, it was found that a considerable proportion of slag was deposited in the checkers and under-checker flues in the regenerator hot chamber.

During the first cold repair, to increase the difference in the velocities of the flue gas in the vertical flue and slag pocket and to increase the amount of slag deposited in the latter, dividing walls were built below the supporting arch of the burner water jacket. The port end was practically converted into a double-flue end (Fig. 2) with a total cross section of the vertical flues of 6.75 m^2. This resulted in improved deposition of slag in the slag pockets and reduced the blocking of the checkers in the regenerator hot chambers. The fuel is fed by a combined burner, through which are fed natural gas, liquid fuel, atomizing agent and oxygen.

TABLE 1. Principal Particulars of Furnace Before and After Reconstruction

Particulars	Amount	
	before reconstruction	after reconstruction
Weight of charge, tons	360	400
Hearth area, m^2	62.9	99.4
Length of bath at level of charging door sills, m	13.0	18.41
Width of hearth at level of charging door sills, m	4.84	5.4
Depth of bath, mm	1350	1000
Thickness of bottom masonry, mm	1750	1285
Height of roof, m	3.3	3.4
Ratio of charge weight to hearth area, ton/m^2	5.7	4.0
Ratio of bath length to hearth width	2.685	3.41
Useful volume of slag pockets, m^3		
Gas	35	–
Air	43	110.8
Total	78	110.8
Volume of checkers, m^3		
Gas	160	–
Air	216	283
Pair of checkers	376	283
Ratio of total volume of checkers to hearth area, m^3/m^2	5.98	2.84

In the thermal working of the furnace using cold natural gas, one of the decisive factors is the heating of the air, and therefore, the lower part of the furnace was completely rebuilt with the construction of double-chamber checkers. According to design, the volume of the cold and hot chambers was made the same. The cross section of the cells in both chambers is 135 · 135 mm. The ten top rows in the hot chamber are forsterite brick (Fig. 3).

Due to considerable overheating of the hot chamber checkers during the entire course of the first campaign of the furnace, the volume of the hot chamber was increased during cold repair to 60% of the total volume of the chambers, the volume of the cold chamber being reduced to 40%. The dimensions of the under-checker flues of the hot chamber were increased (Fig. 4) and the cross-section of the cells of both chambers was increased to 155 · 155 mm.

As a result of the change in dimensions of the checkers, the total heating area was reduced from 3920 to 3660 m^2.

Table 2 gives the technical and economical indices of the reconstructed furnace (for two complete campaigns) compared with a furnace situated alongside and using a mixture of coke-oven and blast-furnace gases.

The duration of a heat in the reconstructed furnace was 1.35 hours (9.03%) less and the output 5.6 ton/hr (20%) higher. These results were obtained with a small number of heats in which the bath was blown with liquid oxygen.

In the second campaign, due to the increase in weight of the heat, the output increased by 8 tons.

The life of the roof up to hot repair was 158 heats; the average roof life in the shop is 151 heats, that is the life of the roof was not impaired, despite the large roof span and the high thermal loads.

After the 60th heat of the second campaign, the furnace was changed over to atomization of the liquid fuel by natural gas. The data in Table 3 show that there was practically no change in the working indices of the furnace when the tar was atomized by natural gas. Although the operation of the furnace with tar atomized by gas concerned the second half of the furnace campaign with tonnage of heats increased by 7.8 tons, the duration of the heats was less and the output of the furnace was higher by 0.8 ton/hr or 2.4%.

The reduction in noise when the liquid fuel is atomized by gas is a considerable advantage, as it eases the work of the melters at the furnace.

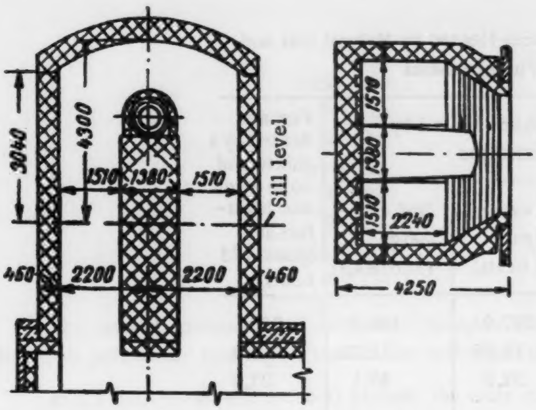


Fig. 2. Reconstructed single-flue port end.

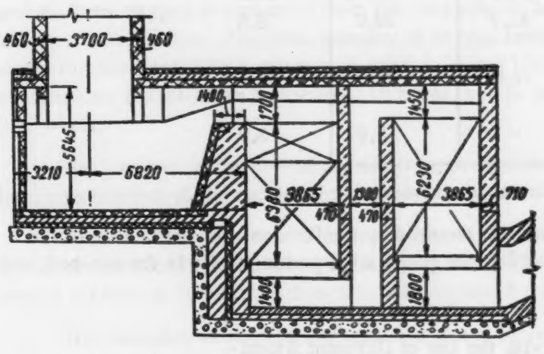


Fig. 3. Two-chamber regenerator checkers.

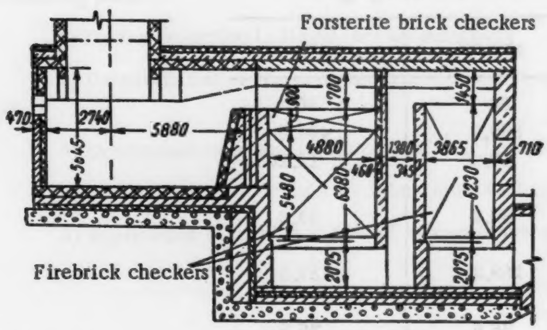


Fig. 4. Reconstructed two-chamber checkers.

The duration of the heat in the reconstructed furnace was less than the average for the shop by 1 hr 10 min in the first campaign and by 1 hr 16 min for the second campaign. This reduction in the duration of the heat occurs mainly in the melt-down and ore-boil periods, and is due to the better conditions for heat transfer and chemical reactions with the larger hearth area. After 70 melts of the first campaign, the thermal loads were increased from 27 to 34 millions kcal/hr, the specific consumption of ideal fuel also increased sharply, due to the occurrence of erosion in the brickwork of the regenerator dividing walls, and considerable blockage of the under-checker flues by slag. This occurred for the following reasons:

1. The large section of the vertical flues resulted in an insignificant change in velocity of the flue gas on its passage from the vertical flue to the slag pocket; this did not promote the precipitation of large particles of slag in the slag pockets and resulted in the premature blockage of the under-checker flues.

2. The bottom flues of the checkers in the hot chamber had an active cross section 2.2 m^2 less than the active cross section of the checkers, which increased the resistance of the furnace, and as the bottom flues of the checkers became blocked, it was practically impossible for flue gases and air to pass through the hot chamber.

3. The dividing walls (from the hot chamber to the intermediate flue) were made with dinas brick without a facing of chrome-magnesite brick. Under the action of the furnace dust, slag and high temperature, the wall burnt through and the hole increased in the course of the campaign. This reduced the heating of the air, a proportion of which did not pass through the hot checkers.

4. The cross section of the cells of 135 × 135 mm in the hot and cold chambers, together with the increased resistance of the checkers, resulted in an increase in the overheating of the hot chamber, due to the increased velocity of the flue gases (2.24 m/sec).

5. In the hot chambers, only the 10 top rows were forsterite brick, which in the high temperature conditions was one of the causes of erosion of the checkers and partial collapse in the first 50 heats.

After the hot repair, in which the checkers were repaired, and the bottom flues of the checkers and slag pockets were cleaned out, the thermal loads were reduced somewhat. The duration of the heats remained practically unchanged during the course of the entire campaign.

The specific thermal load referred to 1 m^2 of hearth area was lower during both campaigns than in a furnace of old construction. This indicates that from the thermotechnical point of view, the furnace operated at a lower thermal stress. The much higher thermal loads in the second campaign were due to impaired heating of the air in the regenerators.

TABLE 2. Working Indices of Furnaces Heated by Natural Gas and a Mixture of Coke-Oven and Blast-Furnace Gases

Index	Furnace heated by natural gas		Furnace heated by a mixture of coke-oven and blast-furnace gases (173 heats)
	1st campaign (22 heats)	2nd campaign (156 heats)	
Average weight of heat, tons	397.0	405.0	368
Duration of heat, hours	12.25	12.23	13.6
Output per hour, tons/hr	32.5	33.1	27.2
Specific consumption of ideal fuel, kg/ton	137.5	160	140.0
Mean thermal load per heat, 10^6 kcal/hr	31.4	36.96	27.0
Liquid fuel consumption, %	31.0	29.0	6.6
Specific oxygen consumption in flame, m^3/ton	32.8	32.7	31.5
Specific oxygen consumption in bath, m^3/ton	–	1.92	3.9

During the second campaign, the fluctuation of the thermal loads was not so great.

For an average consumption of liquid fuel of 30% of the heat required by the furnace, the distribution of the heat during the periods of a heat varied considerably: from 20% in the preparation period to 50% in the ore-boil and lime-boil period.

TABLE 3. Working Indices of Furnace with the Use of Different Atomizing Agents

Index	Tar atomizing agent	
	steam	gas
Number of heats	60	90
Average weight of heat, tons	399.7	407.5
Duration of heat, hr	12.25	12.20
Hourly output (in working hour), tons/hr	32.8	33.6
Specific consumption of ideal fuel, kg/ton	159.2	157.5
Mean thermal load during heat, 10^6 kcal/hr	36.6	36.9
Tar consumption, %	29.3	28.8

The specific steam consumption is 0.8-1.6 kg/kg tar. The brightest flame is obtained with a steam consumption not exceeding 1-1.2 kg/kg tar.

With increase in the hearth area, the area of contact between it and the furnace atmosphere increased, as a result of which the rate of consumption of carbon increased. For the same degree of enrichment of the air with oxygen (25-26%), the rates of combustion of carbon and phosphorus in rimming steels for the furnace described and for a furnace heated by a mixture of coke-oven and blast-furnace gases were:

	Furnace	
	Reconstructed	Ordinary
Melt down:		
% C/hr	0.380	0.357
% P/hr	0.191	0.167
Ore boil:		
% C/hr	0.23	0.20
% P/hr	0.038	0.038
Lime boil:		
% C/hr	0.140	0.125

The rates of combustion of carbon and phosphorus in the reconstructed furnace in the melt-down, ore-boil and lime-boil periods are thus higher than in the ordinary furnaces of the shop.

In the melt-down and ore-boil periods, the rates of combustion of carbon and phosphorus are determined by the ore consumption and the oxidizing capacity of the furnace atmosphere. In the melt-down period, the rate of combustion of carbon in the reconstructed furnace is 13% higher and that of phosphorus 22% higher than in the ordinary furnace, while the ore consumption is only 7% higher. Thus, in a furnace heated by cold natural gas, in the melt-down period, more oxygen is consumed from the atmosphere, and the oxidizing capacity of the furnace with the greater hearth area is greater. The total quantity of oxygen introduced by the ore and scale during the ore-boil is greater in the furnace heated by a mixture of coke-oven and blast-furnace gases. Thus, in the reconstructed furnace, the ore consumption is 1.14 boxes and scale 2.18 boxes, and in the ordinary furnace the corresponding figures are 1.36 and 2.98 boxes.

The increase in the rate of heating (compared with the increase in the hearth area) is due to the lower specific heat consumption of the bath in the reconstructed furnace.

Thus, the reconstruction of the open-hearth furnace with conversion to heating by natural gas and carburation by tar has resulted in a considerable increase in the furnace hearth area and charge. At the same time, the furnace output per heat is 20% higher than the mean output of the shop.

The reduction in running expenses due to the increased output and the reduction in fuel costs produce a saving of more than 1.5 million rubles annually (on the scale of 1961 prices).

Work is currently being conducted at the plant with a view to further improving the thermal conditions on the following lines:

1) Further reduction in liquid fuel consumption;

2) Determination of the optimum quantity and pressure of the natural gas employed for atomizing the liquid fuel;

3) Determination of the dependence of the flame length on the degree of atomization of the liquid fuel;

4) Search for a method for atomizing liquid fuel to a coarser fraction;

5) Application of combined feed of high-pressure and low-pressure natural gas.

RAPID BURNING-IN OF FURNACE BOTTOM

V. L. Maksimov

Il'ich Zhdanov Metallurgical Plant

Translated from Metallurg, No. 6, pp. 17-18, June, 1961

Rapid burning-in of a bottom has been carried out for the first time at our plant in a furnace having a small hearth area. The duration of the burning-in process was 17 hours, while normally it is 83-86 hours. The chemical composition of the burnt-in material was as follows, %:

	SiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	CaO	MgO	P_2O_5	Cr_2O_3	Rest
Powdered magnesite	6.60	2.38	2.47	—	—	1.96	85.44	—	—	0.20
Open-hearth slag	23.52	2.20	1.80	19.34	8.57	33.44	10.42	0.72	0.52	—
Scale	0.60	trace	51.51	46.55	0.77	0.40	0.18	0.38	—	—

After heating up the furnace to a roof temperature of 1770°C, tap-hole temperature of 1700°C and checkers temperature of 1250°C, the bottom was slagged at 11 a.m., scale being spread for 30 minutes in an even layer on the bottom and banks, and also on the back wall and front bank. Altogether, four boxes of 0.85 m^3 capacity of scale was used.

At 11:35 a.m., a start was made with spreading crushed slag, first of all on the banks and then on the back wall and front bank, in all 210 shovels. At 12:15 p.m., the same quantity of slag was scattered and at 1:15 p.m., another 135 shovels. Six boxes of slag were used. At the tap hole, a layer of liquid slag 220 mm thick formed. At 2:10 p.m., it was run off, the remainder being blown out with compressed air.

At 2:20 p.m. a start was made with spreading powdered magnesite on the bottom through the charging doors by means of a deflecting blade and a throwing machine. The first burning-in layer was spread in 20 min. Altogether 6.2 tons of powdered magnesite was spread.

During the heating of the first layer, a mixture consisting of 300 kg magnesite powder and 100 kg scale was spread manually around the tap-hole by means of shovels. The duration of the heating of the first layer was 3 hours. At 4:30 p.m. a sample of this layer was taken (see table). Subsequently, samples of each layer were taken after it had been burnt-in.

Spreading of the second layer commenced at 5:10 p.m. and the throwing machine spread 8.9 tons of powdered magnesite in 30 min. From 5:35 p.m. to 6:25 p.m., 1.5 tons of powdered magnesite and 0.5 tons of scale were spread on the front bank by means of a peel.

At 8:10 p.m., 2 boxes of scale was spread over the entire bath. The duration of heating of this second layer was 3 hr 45 min.

At 9 p.m., spreading of the second layer was commenced; during 25 min, 8.9 tons of powdered magnesite was spread, and 2.7 tons was spread after an hour and then another 2.7 tons after half an hour.

At 10:45 p.m., 4.0 tons of powdered magnesite was spread on the back wall, banks, and front, with 0.2 ton of scale on the top.

At 12:35 a.m., 0.5 ton of powdered magnesite was spread by hand, and at 1:30 a.m. slagging of the bottom was commenced, a quantity of 4 boxes of a volume of 0.5 m^3 being used. Slagging was repeated at 2 a.m. 2 m^3 of scale being used, the same amount of scale being also used at 4 a.m.

At 4:45 a.m., the slag was run off through the tap hole, which was closed with powdered magnesite. At 4:50 a.m., 5 tons of dolomite was spread on the back wall and banks were prepared with dolomite.

The thickness of each burnt-in layer was 65-70 mm.

Chemical Composition of Samples of Burnt-In Layers, %

Layers	Time of sampling	SiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	CaO	MgO	P_2O_5	Cr_2O_3
First	16—30	6.02	2.15	9.04	8.46	0.12	2.00	72.2	0.17	—
Second	20—45	4.10	1.30	11.50	9.01	0.19	2.00	71.04	0.20	0.14
Third	1—35	3.00	2.13	12.00	15.45	0.14	1.00	65.88	0.12	0.29
The same	3—00	2.50	1.09	28.30	7.07	6.17	1.00	59.91	0.612	0.36

At 5:00 a.m., the gas was shut off and charging was begun, sheet-metal clippings being charged on the bottom.

The consumption of materials in burning-in the bottom was, tons:

Scale	25
Crushed slag	5
Powdered magnesite	35
Dolomite	5

After the rapid burning-in of the bottom in July, 1960, the furnace has functioned normally, giving 525 heats per roof and 626 per bottom by April 1.

The stoppages for bottom repairs of this furnace amounted to 2.29%, the average for the shop being 2.75%.

ALL-UNION CONFERENCE ON THE PRODUCTION OF SEMIKILLED STEEL

B. S. Kurapin and A. A. Kazakov

Stalino Branch of the Ukrainian Institute of Metals

Translated from Metallurg, No. 6, pp. 18-19, June, 1961

A considerable margin in increased production and reduction in the cost of steel would result from the replacement of certain sorts of killed steel and rimmed steel by semikilled steel, the principal advantage of which is the higher annual output (by 7 to 10%), due to the reduction in cropping loss at the blooming mill and reduction in the consumption of deoxidizers. In addition, a higher production of semikilled steel results from increased capacity of pouring bays and mold yards.

Semikilled steel has much better properties than rimmed steel, and in a number of cases helps to reduce the cost factor of steel.

The yield of useful material is also higher (by 2-5%) when rimmed steel is replaced by capped steel. The capped steel ingot has a sounder head and less chemical heterogeneity.

The production of semikilled steel has been the subject of considerable development abroad, where it is used for heavy structural plates, bridge plates and furnace plates, for every possible kind of section and also the production of strip for welded tubes, wire, rod, etc. At some of the largest metallurgical plants of the USA, the production of semikilled steel amounts to 10-15% of the entire steel production. Chemical and mechanical capping is used in the production of approximately half the whole of the rimmed steel, the proportion of which forms 55-80% of the total steel production of the USA.

In the USSR, semikilled and capped steels have been produced in insignificant quantities up to the present, although they have long been the subject of investigations at various plants.

Metallurgists are faced with the problem of increasing the production of semikilled steel. In 1959-1960, investigations were carried out at a number of metallurgical plants, in collaboration with scientific research and educational institutes, in developing the technology and mastering the production of semikilled and capped steel.

The object of the All-Union Conference, organized by the Ukrainian Scientific Reserach Institute for Metals and the Stalino Council of National Economy, held in Stalino from January 31 to February 2, 1961, was to exchange experience of work on the investigation and production of these steels, and outlining the ways in which they could be used in the national economy.

At the conference, 16 papers were read by representatives of different plants and institutes. The Ukrainian Institute of Metals, in collaboration with the Makeevka, "Azovstal'" and Krivoi Rog plants have developed a rational technology for the production of semikilled medium carbon steels and mechanically and chemically capped rimmed steels. When killed steel (St. 5 sp) is replaced by semikilled steel (St. 5 ps) the amount of cropping loss at the blooming mill is reduced by 7-10%, and the price of 1 ton of blooms is reduced approximately by 4.5 rubles. The use of mechanical capping of rimmed steels at the Makeevka plant reduced the cropping loss of ingots by about 2%.

The Il'ich Zhdanov plant, with the assistance of the Zhdanov Metallurgical Institute, has developed the production of semikilled steel for sheets of from 9-32 mm thick, permitting a saving of steel of 8.5%. The "Zaporozhstal'" plant, in collaboration with the Central Scientific Research Institute for Ferrous Metals, has developed the production of semikilled steel for hot-rolled sheet, which has increased the output of useful slabs by 2-3%.

At the Kursk Metallurgical Combine, the replacement of killed steels for pit-props and narrow gage rails by the semikilled steels St. 5 ps and St. 6 ps has resulted in a reduction of 9-10% in the cropping loss at the blooming mill. Chemical capping of rimmed steel St. 3 kp by aluminum has also been introduced at this plant.

The Dzerzhinskii plant, in collaboration with the Dnepropetrovsk Metallurgical Institute, has developed the pouring of rimmed steel in bottle-type ingot molds, resulting in a reduction in cropping loss of 2%. At the Zakavkaskii Metallurgical Plant, investigations have been conducted, in collaboration with the Moscow Steel Institute, in developing the technology of the production of semikilled steels St. 2 ps and St. 4 ps, instead of killed steel, for seamless tubes.

At the Enakievsk Metallurgical Plant, the production of Bessemer steel St. 5 ps for concrete reinforcing bars and St. 6 ps for mine rails has been developed. At the "Azovstal'" plant, the melting of steel St. 5 kp, a slightly deoxidized semikilled steel, for mine supports, and steel M45 ps for mine rails, has long been adopted. At the Vyksunsk plant, semikilled steel has been produced since 1946 for strip steel, deoxidized by aluminum through the bottom-pouring fountain.

Metallurgical plants and institutes have thus already worked out the technical processes for the production of semikilled steel with a carbon content of 0.05-0.5% for rolled products of all kinds (deformed concrete reinforcing bars, thin and thick plates, including shipbuilding plates, seamless tubes, etc.). Technical production methods have also been developed for rimmed, mechanically capped steels and for the construction of bottle-type molds, as well as the technical methods of chemically capping rimmed steels.

Conference recommended that the same technology should be used in the production of semikilled and capped steel as in the production of killed and rimmed steels, the technology of deoxidation only being modified. Such steel is poured in open-ended, big end down molds.

In the production of semikilled steels having a carbon content above 0.25%, deoxidation is preferably carried out in the ladle with ferrosilicon (on the basis of obtaining 0.05-0.12% silicon in the finished steel) and 100-300 g/ton aluminum (depending on the carbon content of the steel). Correction of the degree of deoxidation where necessary is effected during pouring by the gradual addition of granulated aluminum to the molds or bottom-pouring fountain while the molds are being filled with steel. Deoxidation (in the ladle or mold) by ferrosilicon alone or by aluminum alone is also possible.

In the production of semikilled steels with a carbon content of less than 0.25% with bottom pouring, the necessary degree of deoxidation can easily be obtained by deoxidizing the steel with granulated aluminum in a quantity of 200-500 g/ton through the fountain at the end of filling the molds.

In top-pouring, deoxidation of steel with a carbon content of below 0.25% is carried out mainly in the ladle with ferrosilicon on the basis of obtaining 0.05-0.12% silicon in the finished steel, and aluminum in a quantity of 300-500 g/ton. For normal, semikilled steel, the cropping loss should on the average be about 5%.

Chemical capping of rimmed steel in bottom pouring should be carried out by the addition of 45%-aluminum or 75%-ferrosilicon to the molds at the end of filling or after filling the molds with steel, and in the case of top pouring, likewise or after 5-10 min.

In pouring mark St. 3kp steel, the following quantities of deoxidizers for capping may be taken as a guide: 150-200 g/ton Al and 300-400 g/ton 75% FeSi. For 0.8 kp, St. 1 and St. 2kp steels, capping requires 250-300 g/ton aluminum.

Mechanical capping is carried out when pouring rimmed steel into bottle-type molds by the use of spherical caps. The height to which the metal is poured in the mold should be regulated so that capping due to contact of the steel with the cap occurs 1-2 min after closing the stopper.

The Conference noted that the main obstacle to the adoption of semikilled steels is the absence of orders for such steels. In addition, the plants have no granulated aluminum.

For the extensive and most rapid introduction of these steels into the national economy, the Conference made the following recommendations:

a) Replace by semikilled steels the large number of killed steels according to All-Union State Standards 380-60, 1050-60 and others;

b) Introduce into the corresponding standards additions and amendments legalizing the use of semi-killed steel for all methods of production (open hearth, converter, Bessemer).

The Conference considered that the investigation carried out and the experience acquired on the production of semikilled and capped steels already makes it possible to proceed to their extensive utilization in the national economy, instead of killed and rimmed steels.

FROM THE NEWSPAPERS

Translated from Metallurg, No. 6, p. 19, June, 1961

Machine-Controlled Melting

An interesting experiment was recently carried out in Kiev: melting of steel in the furnaces of the Dneprodzerzhinsk metallurgical plant was controlled by scientists from the Computer Center of the Academy of Sciences of the Ukrainian SSR, situated 500 km from the plant.

The scientists together with metallurgists of the Dneprodzerzhinsk plant and the Denprodzerzhinsk Technical College prepared the automatic control of the Bessemer process by an electronic computer. A direct link was established between the Bessemer shop in Dneprodzerzhinsk and the Computer Center in Kiev. From the first minutes of the heat, signals began to enter the electronic computer "Kiev." At exactly the prescribed time when the heat was ready, the machine gave the command for the steel to be poured. Three heats were made in this way.

Furnace Bottoms Repaired by a New Method

A new method of repairing furnace bottoms has been proposed by Comrade Krest'aninov, senior foreman of the furnace section of the Stalin Zlatoustovsk metallurgical plant. By his method, holes are not repaired with powdered magnesite but with a chrome-magnesite paste prepared from chrome-magnesite brick. Old bricks are ground to powder in an edge-runner mill and the powder is made into a paste.

According to provisional calculations, the new method of repair promises to be very profitable. In January and February alone, 25-30 hours were saved, due to which many more tons of metal have been melted.

On the 1965 Level

The metallurgical plant "Dneprospetsstal'" in the last quarter of last year reached the 1965 level in steel melting. The plant reconstructed 5 electric furnaces by its own efforts. Two powerful electric furnaces have been built more than a year before the fixed term. Recently, the first steel-melting shop received the title of Communist Labor Shop.

The workers in the plant displayed considerable enthusiasm in qualifying for the right of calling themselves a Communist Labor Enterprise.

Giant Electric Furnace

Soviet engineers have worked out a project for the largest three-phase three-electrode electric furnace in the world. The furnace will melt about 250 thousand tons of high quality steel annually, and its output will surpass that of a 400 ton open-hearth furnace.

It is intended to put this gigantic electric furnace into operation in 1965.

THE PRODUCTION OF ECONOMIC COLD-BENT SECTIONS

I. S. Trishevskii, L. N. Soroko, and A. S. Naidenov

Ukraine Institute of Metals, "Zaporozhstal'" Plant

Translated from Metallurg, No. 6, pp. 20-23, June, 1961

An extensive use of bent sections is one of the greatest possibilities for saving metal. In comparison with the usual rolled products the use of bent sections assures, on the average, about a 25% savings in metal due to the more efficient distribution of the metal along the section and because it is possible to manufacture thin-walled shapes with any cross-sectional form.

The production of bent sections on the shaping and bending mill is a highly efficient process assuring a good quality of the finished product. In addition, the capital investment for the construction of shaping and bending mills is less, the time needed for installation is considerably shorter, and it pays for itself faster than hot-rolling mills.

The "Zaporozhstal'" Plant has installed two shaping and bending units, completely mechanized assemblies consisting of a group of machines that shape the starting billet, forge the bent section, and transport and pack the finished product. The arrangement of the equipment provides two continuous unidirectional flows of metal for each of the units.

The coiled starting material is delivered from the feeding device to the uncoiler, is then straightened and cut by flying shears into measured lengths. These lengths are shaped in the grooved rolls of the shaping and bending mills, then covered with a layer of lubricant and stacked in packs.

The sections are shaped by cold deformation in the roll passes by a gradual bending. The number of stands in which shaping occurs depends on the complexity of the configuration and dimensions of the section of the finished shape, and also on the quality of the starting metal.

Bent sections at the "Zaporozhstal'" Plant are manufactured from pickled and unpickled hot-rolled and cold-rolled flat products with trimmed edges of steels St. 0-St. 3, 08, 10, 15, 20, 25, 30 (rimmed and killed), 09G2, 10G2, 14KhGS, 15Kh, 20KhGS, NL-1, and NL-2.

One of the shaping and bending mills is designed to produce irregularly shaped sections with a very diverse cross-sectional contour from billets 2-8 mm thick, 80-500 mm wide with a maximum height of the section to 160 mm. The length of the flat products being shaped can be 3-12 m. The mill has 14 working stands with a common drive from two 480-kw motors with a shaping speed up to 2.5 m/sec.

The second mill can produce wider sections, such as ribber plates, corrugated sheets, casings of various types, large angles, C-shapes, and U-shapes. These are manufactured from low-alloy steels 1-6 mm thick with a width of the starting material of 400-1500 mm, a thickness of 1-5 mm at a width of 400-1100 mm with a tensile strength of 50 kg/mm^2, and a thickness of 1-5 mm at a width of 400-900 mm with a tensile strength of 60 kg/mm^2. The maximum height of the sections being produced is 200 mm at a length of the flats being shaped of 3-11 m. The mill has 20 working stands with a common drive from two 300-kw motors with a shaping speed up to 3 m/sec.

The experience of mastering the production of bent sections at the "Zaporozhstal'" Plant revealed certain shortcomings in the planning of the shop, in the design and operation of the equipment, and in certain characteristics of the planned technology.

The problem of manufacturing shaped collars, from which the work rolls of the mill are assembled, was not solved in the plan of the shop. To assure normal operation the shop should have a separate roll-turning shop with a hot-working section and a section for building up the collars of the rolls where the working surface has been worn.

The disparity between the area set aside in the warehouse for the finished goods and the productivity of the shaping and bending assemblies is a shortcoming in the planning of the shop. When designing and constructing new shops it is necessary to provide for considerably larger areas for storage of finished goods and also for areas to place the needed amount of shelving under the shaped collars of the work rolls.

The complicated adjustment of the flying shears and the unsatisfactory cutting of the coiled material to measured lengths on the 2-7 × 80-500 mill considerably hampers normal operations, as a result of which deviations are obtained in the longitudinal dimensions of the strips being cut from the leading and rear ends of the coil.

The structure of the vertical rollers mounted between the roll stands is inadequately rigid and does not hold down tightly flat stock of irregular cross-sectional form or accurately guide them between the stands. Due to this shortcoming we cannot use the vertical rollers for bending sections to angles greater than 45° and this makes it necessary to have a greater number of pairs of horizontal rolls for shaping sections.

The design of the shaping and bending mills limits the dimensions of the work rolls such that the thickness of the body of the lower roll at the site of the key groove is only 19 mm. This is completely inadequate for restoring the shape of the groove by regrinding after wear. The life of the rolls is shortened.

Operational experience has shown that roll changing when transferring from one shape to another requires rather considerable time since it is necessary to dismantle and assemble numerous parts of the roll stands.

Tables with vertical guiding rollers were installed along the shaping axis between the mill stands to hold down the strips. However, it was not possible to prevent shifting of the strips along the axis of the rolls by using rollers. The strips of the finished section were produced with different widths of the flanges, considerably exceeding the deviations permitted by the standard. The distance between the stands of the mill is 1400 mm. The strip exiting from the stand could not be delivered properly to the following stand.

Slide guides (Fig. 1) consisting of a cast iron base, in the upper part of which a channel was formed corresponding in shape to the configuration of the angle of the section in a given pass, were designed, manufactured, and installed on the mill to assure normal operation of the mill. Angles are fastened from the sides to the base by screws. Their height is regulated by means of an oval hole under the screw.

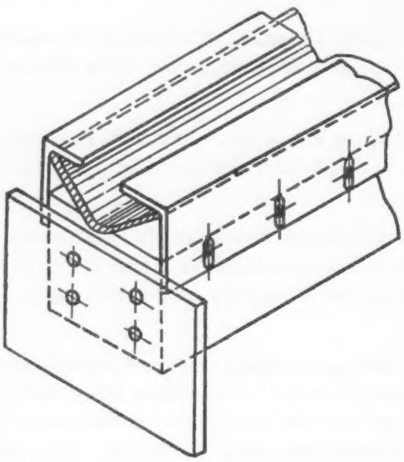


Fig. 1. Guides for angle strips.

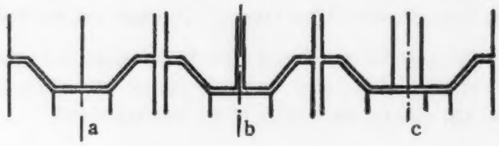


Fig. 2. Diagram of sectional roller for shaping U-sections.

The guides are fastened by screws to a beam installed in place of the bed roller and to a plate welded to the table of the vertical rollers. The guides were installed on the delivery side of the work rolls and kept the strips from shifting laterally as they moved from the rolls to the vertical rollers.

The use of slide guides completely eliminated ejection of strips from the mill, improved the quality of the sections, and made it possible to manufacture them with small deviations from the requirements of All-Union State Standard 8276-57. However, when manufacturing small angles (40 × × 40 × 3, 50 × 50 × 3) deviations nevertheless occur that exceed those permitted by a factor of 2 or 3.

Several thousand tons of angles have presently been manufactured, experience in their production has been accumulated, but it is still necessary to improve appreciably the quality of small angles.

To eliminate the differences in the flange widths of the sections, a new design has been worked out for a rolling role guide, which will soon be tested.

The quality of bent sections when shaped piece-by-piece is worse than when produced continuously because the conditions of deformation of the leading end, the center, and the rear end of the strip are different. As a result, the cross-sectional dimensions of the shape at the ends of the strip are produced with certain deviations. The productivity of piecemeal shaping is also lower than continuous shaping.

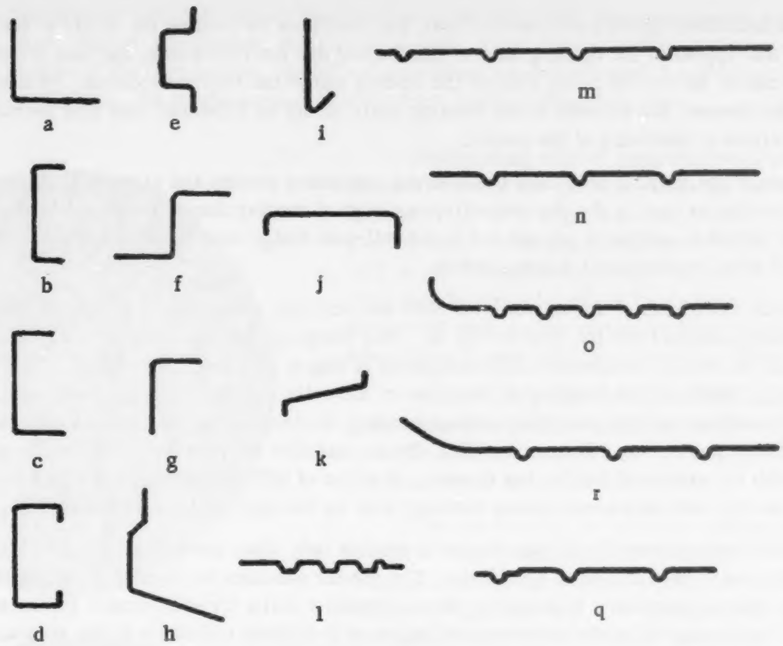


Fig. 3. Bent sections mastered at the "Zaporozstal'" Plant: a) Equal-leg angle; b) U-section; c) unequal-leg U-section; d) C-section; e) channel; f) Z-section; g-k) sections for window and transoms for industrial buildings; l) finned plate; m and n) sections for the facing of the lower belt of all-metal railroad cars with three and five crimps, respectively; o) facing of the upper belt of all-metal cars; p and q) sheets for the side walls of refrigerator cars.

The use of continuous shaping on the efficient shaping and bending assemblies is presently impossible because we have no equipment that will cut the finished section in the production line at a speed of 3 m/sec.

Design and Operating Conditions of Shaping

Section	Roll-pass design	Increase in the bending angles by passes, deg											
		1	2	3	4	5	6	7	8	9	10	11	12
U-shape 160 × 80 × × 2.5 mm (All-Union State Standard 8279-57)	planned	0	12	12	10	10	8	8	7	7	6	6	6
	working	0	8	8	10	12	12	10	10	10	8	2	—
Equal-leg angles 250 × 250 × 3 mm (All-Union State Standard 8276-57)	planned	0	4	8	6	6	6	6	5	4	2	—	—
	working	0	6	6	8	8	8	9	2	2	—	—	—

The use of maximum bending angles of the section elements in the first passes and a decrease in their magnitudes in subsequent passes provides the most efficient technological conditions which take into account the hardening of the metal in the shaping process during continuous shaping. The experience of shaping by individual strips showed that it is necessary to use small bending angles in the first passes until the curvature at the bending sites are formed

and the section has sufficient rigidity; as a result of this, the conditions for feeding the metal to the roll grooves are improved, fissures that appear at the bending sites on the leading end are eliminated, and also the magnitudes and length of the elements of the section being bent on the leading end of the strip are reduced. As soon as the curves of the bending sites are formed, the increase in the bending angle should be increased, and then decreased as the finishing pass approaches (due to hardening of the metal).

The difference in the shaping conditions between the continuous process and piecemeal shaping is apparent by comparing the conditions used in the planned roll-pass design of starting shapes developed on the basis of production experience with the continuous process and in the roll-pass design used on the shaping and bending mills of the "Zaporozhstal'" Plant in piecemeal shaping (table).

Due to the wide assortment of shapes, the work rolls are sectional, consisting of a shaft on which are attached collars, whose working surfaces form the groove (Fig. 2). This design makes it possible to work out universal roll-pass designs that can be used to manufacture different groups of shapes on a single set of rolls. This is possible due to the use of gasket rings which can be installed in the joints of the collars of the upper and lower rolls. Thus, during the production of U-sections on rolls assembled without packing, sections are shaped having a minimum web height and a maximum thickness (Fig. 2a). Gasket rings (Fig. 2b) are installed between the collars of the upper roll in order to shape sections with the same web height (but thinner). Sections of different thicknesses with a considerable web height are shaped on rolls with additional collars installed both on the upper and on the lower rolls (Fig. 2c).

The use of universal systems of roll-pass designs is possible only when the radii of the transitional sites are the same for groups of dimensions of the same type shape. The present standards for bent sections, which were worked our when there was still no experience in producing them, provide a radius for each section thickness. To observe this condition when producing the entire assortment of angles of U-sections called for by the standards would increase the required stock of rolls and almost triple the cost.

The "Zaporozhstal'" Plant has already mastered the production of 17 types of sections of 60 dimensions (Fig. 3).

The assortment will be expanded by the output of sections with open and closed cross-sectional forms.

IMPROVING THE QUALITY OF SHEET AND PLATE ROLLS

A. S. Beshlik

Director of the Lutigino Roll Plant

Translated from Metallurg, No. 6, pp. 23-26, June, 1961

Three basic types of chilled cast-iron rolls are usually used in sheet and plate rolling production: plain (carbon), chrome-nickel, and magnesium-treated cast iron rolls.

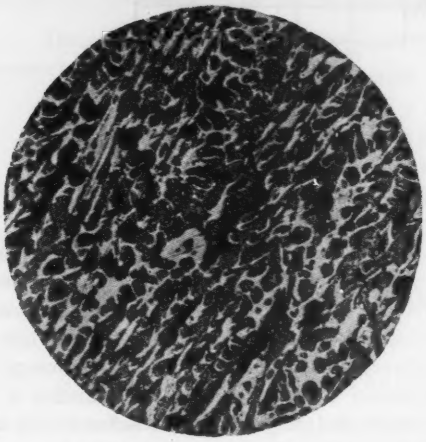
With the development of the rolling industry, the appearance of new types of rolling mills, and the increased demands for quality rolled products, the carbon steel rolls having low indexes of strength have retarded the increase in the output of rolled products on certain mills. Investigations began to find new alloys that would provide higher service properties for rolls.

Two-layer chrome-nickel rolls with a carbide-martensite structure of the outer layer and a pearlite-graphite core have been used since 1936 on the finishing stands of the continuous sheet mill. Such rolls are also used on the stands when temper rolling flat strips and thin sheet and also on the last stands of the skelp mills. Special attention is now being devoted to those rolls due to the increase in the number of continuous sheet mills.

Productivity has considerably increased since 1950 as a result of using rolls made of cast iron treated with magnesium on the two-high stands, including the thin-sheet stands, of the hot-rolling sheet mills. The durability of these rolls proved to be by a factor of 2-3 high than the durability of rolls of carbon steel with a lamellar form of

graphite. Magnesium-treated cast-iron rolls on the two-high hot-rolling mills have completely replace chilled carbon rolls. Sheet, plate, dipped, transformer, and electrical grade sheets are successfully rolled in rolls of magnesium-treated cast iron in spite of the fact that the operational conditions are complicated the entire time: the load on the rolls systematically increases, the temperature of heating them during rolling rises, etc.

a



b

Fig. 1. Microstructure of the chilled layer of rolls of magnesium cast iron with a phosphorus content of: a) 0.4-0.5%; b) 0.06-0.10%.

Sheet-rolling rolls of magnesium-treated cast iron with a spherical form of the graphite, although they exceeded chilled common steel in strength, still had insufficient plastic properties. Testing them on the planishing stands of the continuous sheet mill at the "Zaprozhstal'" Plant was unsuccessful: certain rolls were used in stands for which they were not intended or where they could produce the greatest effect; others did not show any advantages in core strength over rolls of other types.

The operating conditions (one drive wobbler under large loads and a considerable difference in the length and diameter of the roll barrel) demand from the roll material high strength and ductility of the necks and wobblers.

The low ductility of cast-iron rolls (even if the cast iron is treated with magnesium) are caused by the unavoidable presence of a brittle component, a phosphide eutectic, in the structure of the cast-iron roll. The phosphide inclusions are formed in the cast iron when the phosphorus content exceeds 0.10%; with an increase in this content the amount of phosphides increases, their form changes (instead of separate islets there are scraps of the network along the faces of the austenite grains). The brittleness of the rolls increases in proportion to the increase in the amount of phosphides.

In the second half of 1960 we began casting at the Lutigino Roll Plant low-phosphorus chilled rolls from magnesium-treated cast iron with a phosphorus content not exceeding 0.10%. The first experimental lots were cast for the stands of the two-high mills for hot-rolling sheet and plate. The low-phosphorus steel-making pig iron of the Almaznyanskii Plant smelted from Krivoi Rog ores was used as the charge for the sheet and plate. Roll scraps were not used in the melting furnace and cupole due to their high content of phosphorus. The pig iron was melted according to the technology developed for chilled rolls of magnesium-treated cast iron containing the usual phosphorus content.

The microstructure revealed that the low-phosphorus rolls had no phosphides in the casting (small islets were observed now and then in the upper neck) and that a comparatively large amount of ferrite was in the gray zone of the roll containing the same carbon and silica contents. Figures 1 and 2 show the microstructure of the chilled layer and gray zone of the sheet-rolling rolls of magnesium cast iron with the customary and low-phosphorus content.

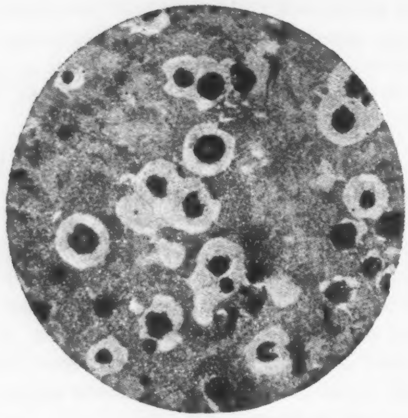
The change in the microstructure is accompanied by a small decrease in the hardness of the low-phosphorus rolls in the chilled layer and in the gray zone (Fig. 3).

The strength of the low-phosphorus rolls was considerably higher than the strength of the rolls having a phosphorus content of 0.4-0.5% (Table 1).

The mechanical properties of the rolls of magnesium-treated cast iron considerably improved as a result of lowering the phosphorus content. In addition to the increase of the strength of the core, the absence of a brittle constituent in the microstructure fostered an increase in toughness and wearability of the chilled layer. The operational

data for the first experimental lots of rolls confirmed their high quality. At the "Serp i Molot" Plant, where fractures were one of the main causes for rolls being put out of service, the durability of the mangesium low-phosphorus rolls proved to be several times higher than that of rolls with the usual content of phosphorus. At the Frunze Konstantinov Plant 95% of the rolls were put out of operation due to crumbling of the chilled layer; the use of low-phosphorus rolls almost tripled the durability.

a



b

Fig. 2. Microstructure of the gray zone of rolls from magnesium treated cast iron with a phosphorus content of: a) 0.4-0.5%; b) 0.06-0.10%.

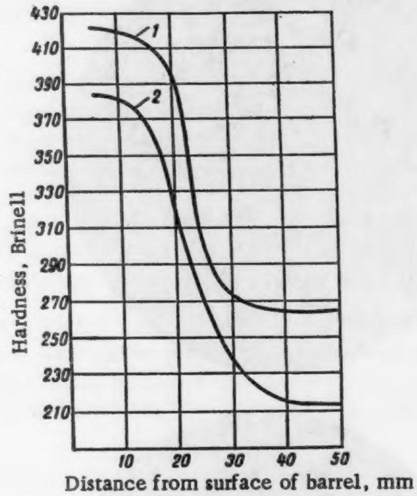


Fig. 3. Hardness of the chilled layer of rolls of magnesium cast iron with a phosphorus content of: 1) 0.4-0.5%; 2) 0.06-0.10%.

In recent years we have extensively used electrodes containing 8-10% tungsten for surfacing the working surface of rolls. Surfaced rolls have considerable advantages over those unsurfaced. However, in comparison with cast-iron rolls, steel-surfaced rolls have a number of shortcomings: uneven hardness over the barrel surface, the formation of a coarse erosion network during operation, a deterioration in the surface of the article being rolled, and the high cost of surfacing.

The comparative durability of the steel, steel-surfaced, and cast-iron common rolls is shown in Table 2 for the Alchevskii Metallurgical Plant.

TABLE 1. Mechanical Properties of the Gray Zone of Sheet-Rolling Rolls of Different Types

Roll types	Tensile strength, kg/mm²	Impact strength, kg/mm² specimen size	
		10×10×60	20×20×60
Common with 0.4-0.5% P	10.0	0.20	0.50
Magnesium with 0.4-0.5% P	24.0	0.40	0.80
Magnesium with 0.06-0.10% P	31.0	0.70	2.25

The use of casting low-phosphorus rolls of magnesium cast-iron will permit us to introduce them widely in place of steel rolls: all the back-up rolls of the plate mills, the work rolls of the intermediate stands of the sheet mills, the rolls of the spreading stand, the rolls of the blooming and slabbing mills can and should be made from the strong and cheap material – magnesium cast iron with a low (to 0.10%) phosphorus content.

TABLE 2. Durability of Work Rolls on the Finishing Stand of the 2800 Four-High Mill, Alchevskii Plant

Roll type	Average durability for 1 roll		Frictional wear between roll changes, mm	Productivity per mm of working layer, ton
	hr – min	ton		
Steel grades 60KhN (without heat-treatment)	3 – 30	337	2 – 3	134
Steels 9Kh2 (heat-treated)	8 – 45	943	1.0 – 1.5	754
Steel surfaced	9 – 20	1260	up to 1.0	1260
Cast iron, common	13 – 10	1624	up to 1.0	1920

Of course, the success of introducing these rolls is possible only if they are correctly operated.

Achievements in developing new types of rolls for rolling sheets and plates in the current Seven-Year Plan would be considerably greater if the material of the rolls were taken into account when designing the mills and the rolling-mill specialists would devote greater attention to the problem of the operating conditions of the rolls.

The cooperation of the roll-casting operators, rolling-mill specialists, and the designers of rolling mills should be developed and strengthened.

FURNACE FOR HARDENING RAILS

G. N. Kryukov, Senior Foreman of the Heat-Treatment Department of the Rail and Beam Shop, and I. I. Kharybin, Director of the Rolling Trains of the Thermotechnical Laboratory, Dzerzhinskii Plant

Translated from Metallurg, No. 6, pp. 26-29, June, 1961

A furnace with a rolling hearth for hardening rails (figure) has been operating for two years at our plant. This furnace heats cold rails arriving from other plants and also hot rails from our own production, which go directly from the hot-cutting saws and are preliminarily cooled on racks or in slow cooling pits to 500-300°.

The heating conditions of the furnace are calculated to heat Type R-43 and R-50 rails 12.5 m long to 820-840° in order to harden the heads to sorbite in the hardening machine.

The furnace is divided into seven zones, each of which has an individual supply of gas that is controlled to maintain a constant given temperature in the zone. The furnace is heated by a mixture of coke-oven and blast-furnace gas with a heat value of 1200 kcal/m^3 and a pressure of 1200 mm H_2O. The gas is burned by means of injection burners with a capacity of 70 m^3/hr.

The rails in the furnace move along a roll table having two speeds: 0.65 m/sec which equals the speed of the charging roll table and is used to deliver and discharge the rails and during idle running of the furnace, and a speed of 0.12 m/sec for reversing the rails in the furnace. This speed makes it possible to hold the rails in the furnace for a given time and eliminates bending of the rollers and sagging of the rails between them.

Normalized rails are discharged at the sides of the furnace by buggies with peels which seize one rail each from behind the lower feather.

The plant introduced substantial changes in the design and, in particular, in the gas-supply networks while the furnace was being constructed. Gas-mixing devices were used which increased the pressure of the mixture, and the arrangement of the blower heads was changed.

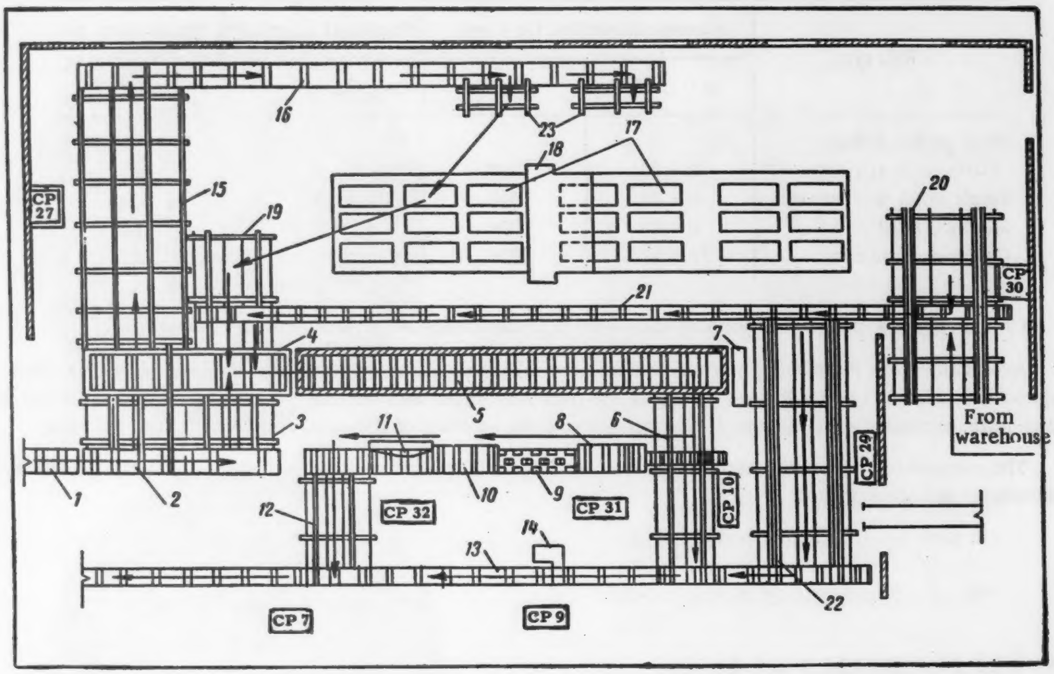


Diagram of the furnace layout for normalizing rails and its auxiliary equipment: 1) Roll table from saws; 2) receiving roll table; 3) rack; 4) loading roll table; 5) furnace with roller hearth; 6) unloading device; 7) heat-shielded room; 8) manipulator; 9) machine for hardening the head of rails lengthwise; 10) manipulator; 11) bending machine; 12) transfer rack; 13) roll table; 14) saw for selecting tests; 15) cooler; 16) roll table; 17) slow-cooling pits; 18) ground-type crane; 19-20) receiving grates with transfer tracks; 21) roll table; 22) rack; 23) mechanized racks; CP) control panel for the individual units of equipment.

The coke-oven and blast-furnace gas mixture is delivered from the gas-booster station to the general furnace gathering main which is connected to all zones by means of taps having choke-regulating valves. Each zone has two main arranged on each side, from which the taps lead to the burners of the lower and upper heating units; in addition to this, to control and regulate the heating conditions of the furnace we installed three thermocouples (two in the roof and one in the lower part, under the rollers). The signals from the first roof and side thermocouples are sent in pairs to the six-point electron potentiometers; these readings are used for controlling the uniform distribution of the temperature along the length and height of the furnace. The signals from the other roof thermocouple are sent to self-recording instruments with a slave mechanism installed on the rotating flue valve.

The pressure of the coke-oven and blast-furnace gas mixture in the general gas line is controlled by a membrane manometer and a secondary electrical self-recording instrument, which receives an impulse from the connecting pipe installed in front of the first gate valve.

Gas delivery and registration is monitored by a gas meter which receives an impulse from the measuring diaphragm.

The following substantial shortcomings were detected while operating the furnace:

a) It was difficult to maintain a given temperature throughout the length of the furnace;

b) The heat output in the seventh zone was inadequate;

c) The rails being discharged had an uneven temperature lengthwise. The co-workers of the Heat Engineering Laboratory of the plant along with the workers of the rail and beam shop did considerable work to eliminate these shortcomings.

Heating conditions were worked out for each zone (from the first through the sixth). By means of the optical pyrometers installed at the end of the fifth and sixth zone, we measured the temperature of the normalized rails and, during idle operation, the temperature of the hearth rollers; we also monitored the heating conditions.

The distribution of the thermal loads longitudinally in the furnace can be considered uniform since the burners for bottom and top heating were arranged symmetrically on both sides.

Indexes of the Mechanical Properties of Raw and Heat-Treated Rails*

Rail type	Number of melts	Constant in steel, %		State of metal	Hardness H_B			σ_s, kg/mm²	σ_B, kg/mm²	δ, %	ψ, %	a_k, kg m/cm² at testing temperatures, °C					
		C	Mn		on rolling surface	at depth of hardened layer, mm: 5	10					+20	0	−20	−40	−60	+20 after aging
Bessemer	12			R	240	—	—	50.2	90.0	13.8	31.0	1.5	1.2	1.1	1.1	—	0.7
The same	5	0.53—0.73	0.63—0.90	N	230	—	—	46.4	88.0	16.3	37.5	2.7	2.4	1.7	1.5	—	1.5
R-43	12			H	360	320	310	83.8	113.7	13.7	41.2	3.7	3.6	3.3	3.1	2.6	2.4
Bessemer	9	0.61—0.77	0.60—0.87	R	—	—	—	47.9	92.1	11.6	23.3	1.6	1.2	0.9	0.7	—	0.6
The same	10	0.61—0.77	0.60—0.87	N	—	—	—	44.4	86.4	13.8	31.3	2.8	2.1	1.6	1.4	1.1	1.2
R-50	8	0.58—0.77	0.60—0.86	H	347	321	317	82.3	113.8	13.1	41.3	4.0	3.6	3.6	3.2	2.9	3.3

Designations: R = raw metal (after rolling); N = normalized; H = hardened.

* Average indexes shown.

The burners were arranged only on one side in the seventh zone; the other side had a port for discharging the heated rails that was opened at all times in order to observe if the rails were caught at the time of discharge.

The distribution of the thermal loads by zones according to the layout is as follows:

Zone number	1	2	3	4	5	6	7
Length of zone, m	13.5	13.0	13.0	13.0	13.0	13.0	16.5
Number of burners in zone	44	44	44	48	40	48	23
Thermal load of zone, kcal/hr	3.6	3.6	3.6	3.96	3.36	3.36	1.92
Consumption of gas per zone, m³/hr	3000	3000	3000	3300	2800	3300	1600

We see from these data that the thermal load in the seventh zone is lowest in spite of having the greatest length.

Uniformly heated rails entering the discharge zone (especially during the winter) were rapidly cooled in the furnace itself, whereby the difference in the temperature of the front and rear ends was 80-100°. End hardening of such rails did not yield positive results.

To increase the heating power and to raise the temperature in the seventh zone we carried out experimental investigations of the operation of injection burners. The nozzle of the burner was gradually bored out, thus increasing the area of gas flow and, consequently, the output of the burner. Its design made it possible to bore an inside diameter of the nozzle up to 22 mm. A burner with this nozzle operates without spurts and jumps of the flame at a gas pressure of 1200 mm H_2O in front of the first valve and a heat value of 1200-1300 kcal/hr.

Now the nozzles of all 23 burners have been bored to a diameter of 22 mm as a result of which the heating power of the zone has more than doubled.

However, in spite of the increase in the heating power, the forward ends of the rails are somewhat cooled off because at the end of the zone there was a considerable undercurrent of cold air from the discharge side of the rails. The difference in the temperature of the front and rear ends of the rails, especially in the winter, varied within considerable limits. To eliminate this shortcoming we installed an additional three burners (two in the end walls and one in the side wall) at the end of the seventh zone and thus the thermal load was increased to $4.62 \cdot 10^6$ kcal/hr. In addition, we eliminated the undercurrent of air, thus making it possible to maintain a given temperature throughout the length of the zone.

In addition to the shortcomings described above, the furnace had still another substantial fault. The furnace is maintained from two control posts: a) one for delivery and movement of the rails along the furnace,and b) the other for discharge of the normalized rails from the furnace and their transportation for hardening. The signals for carrying out these operations are sent to the operators of both control posts by gestures and whistles from the furnace attendants and the operators do not always understand. It was suggested that television be installed at the control posts so that the operator delivering the rails to the furnace would see their movement along the furnace, and the operator of the discharging post would observe them in the seventh zone and catch them with hooks.

Other shortcomings were also revealed during operation of the furnace. For example, at the instant the temperature reaches that given, the supply of gas is automatically cut off (especially, during idle running) by a slave mechanism; the gas pressure in front of the burners drops considerably, the velocity of the gas flow becomes smaller than the velocity of flame propagation, as a result of which spurts are produced.

During operation of the furnace, scale adheres to the hearth rollers and builds up around the circumference. When the heated rails are discharged from the seventh zone, the base head are considerably galled which causes these rails to become second grade or to be sent for additional burring.

It is very inconvenient and time consuming to replace the furnace rollers when they are put out of operation.

There are no water traps throughout the entire length of the general gas main. During operation of the furnace the main accumulated a large amount of condensate which, when it gets into the burners, causes them to stop temporarily, and at low temperatures of the ambient medium, it freezes in the tubes which conduct the gas to the burners, as a result of which the burners were out of operation for a long time.

In addition to this, we must add to the shortcomings of the furnace the very close arrangement of the peepholes to the flame, as a result of which their glass is frequently ruined; and also it is difficult to get at the bottom row of burners for servicing.

The shortcomings noted above should be taken into account and eliminated when designing new furnaces for heating rails to normalize or harden them. When operating such furnaces we must take into consideration that the hearth rollers must be switched on only when the temperature in the furnace reaches about 450-500°. The rollers jam and do not turn at lower temperatures.

Operating experience of the furnace showed that surface hardening of rail heads along the entire length by independent heating considerably increases the mechanical properties in the hardened zone (see table).

In comparison with "raw" rails, the yield strength of heat-treated rails was increased by a factor of 1.7, the tensile strength by 1.3, the relative necking down by 1.7, toughness at +20° and -40° by 2-3, and Brinell hardness by 100-150.

The heat-treated rails were tested on experimental sections of the track where they were subject to high-speed heavy rolling stock. The life of the rails according to the preliminary data was increased by a factor of 2-2.5.

NEW BOOKS

Development of the Rolling Industry in 1959-1965, by A. I. Tselikov, E. R. Shor, Moscow, Metallurgizdat, 112 pp., 1960

Translated from Metallurg, No. 6, p. 29, June, 1961

This brochure examines the main trends in rolling and tube production for 1959-1965. New progressive processes are described for rolled goods that will considerably increase the output of rolled goods and tubes (a combination of various processes of producing rolled goods in a production line, an increase in the speed of the working processes, and also accuracy in the dimensions of the rolled goods).

A separate chapter of the brochure is devoted to the problem of automation and mechanization of the rolling industry; technical and economic indexes are given for the equipment being designed and installed in USSR plants during the current Seven-Year Plan.

The brochure is of interest to engineers and technical workers of the metallurgical and machine-building industry and also to qualified workers and students of technical colleges.

THE WORKING METHOD OF STEELWORKER V. I. BOLDYREV

V. K. Laptev and Z. N. Sarukanyan

V. I. Lenin Azerbaidzhan Tube-Rolling Plant
Translated from Metallurg, No. 6, pp. 30-31, June, 1961

The creative activity of the working masses grows with each year. From all corners of our great Motherland arrives news about the prescheduled fulfillment of the production plans, about the increased commitments the collectives of the enterprises have pledged, about people who by their selfless efforts have shattered the concepts of time and man's potentialities. One such person is V. I. Boldyrev, steelworker of the Azerbaidzhan Tube-Rolling Plant; and we will tell about him in this article.

Demobilized in 1952 from the ranks of the Soviet Army, Vasilii Ivanovich Boldyrev started work as an assistant steelworker at the open-hearth shop of our plant,and three years later, in 1955, V. I. Boldyrev became a steelworker.

By constantly increasing his qualifications, studying the experience of the senior comrades, by attentively observing the methods of fast-working steelmen, Boldyrev became one of the best steelmakers in Azerbaidzhan.

The high rank of Brigade of Communist Labor, the first in the shop, was awarded to V. I. Boldyrev's brigade in December, 1959.

V. I. Boldyrev is not only a good producer, he also carries out considerable socialistic work. In March, 1959, he was selected a deputy of the Supreme Council of Azerbaidzhan SSR.

Steelworker V. I. Boldyrev was awarded the order of the Red Banner of Labor for achieving high productive indexes and was entered in the book of honor of the Council of National Economy, Azerbaidzhan SSR.

Now V. I. Boldyrev conducts a school of high-speed steelmaking.

Arriving and Leaving the Shift

As a rule V. I. Boldyrev arrives at work 30-40 minutes before the shift starts, acquaints himself in detail with the operation of the furnace, attentively checks the cleanliness of the working areas, the condition of the roof, heads, checkers, regenerators, hearth (if the furnace has been tapped), the accuracy of the control-panel instruments, the presence of charging, refining, and dressing materials, and deoxidizing agents. The steelworker immediately reports the results of the inspection to the foreman, makes appropriate notations in the shift logbook and gives orders to his subordinates.

Boldyrev very carefully makes preparations for leaving the shift: he checks all working sections, the condition and presence of tools, the cleanliness of the working areas, the readiness of dressing materials, deoxidizers and other materials, eliminates troubles that have appeared, acquaints his replacement in detail with the operation and condition of work and reports troubles which occurred in the furnace operation while smelting.

Fettling

V. I. Boldyrev's brigade begins fettling the furnace at the time of refining the melt. To carry out fettling successfully, the steelworker at the time of the preceding melt examines and tests the fettling machine, checks the presence and quality of the fettling materials which together with the machine are located at the most convenient places. The brigadeer participates directly in the fettling operation, indicating the places which must be fettled with the most care. The assistants from neighboring furnaces participate in this work along with the brigade members. The fettling materials are first loaded from the side where the combustion products are discharged, where the fused sections are best seen. During tapping, V. I. Boldyrev and the brigade fettle the corners, slopes and rear wall,as

these parts of the furnace become exposed, until all metal and slag are removed. Then the steelworker together with the foreman examines the hearth. If it is in normal condition, the taphole is immediately covered. If stagnant areas of metal and slag are found they are blown out with compressed air, then the rotary fettling machine fettles the rear wall and slopes of the furnace, after which charging begins. Finally, the front wall is fettled during charging – during the intermediate heating period of the charge. The thermal load during fettling is held at a level such that heat losses through the opened ports are compressed and the roof temperature does not drop. The consumption of gas during fettling is 1650 m^3/hr, fuel oil 400 kg/hr, exhaust air 18,000 m^3/hr, the thermal load $16.8 \cdot 10^6$ kcal/hr.

The method and organization of fettling that is used saves up to 10 min for each fettling operation and cuts down the duration of melting as a result of the high temperature conditions; also fettling materials are saved and their weldability improved.

Charging the Round

The duration of melting in many respects depends on a successful charging operation. Correct charging is exceptionally important for high-speed fusion; therefore, V. I. Boldyrev participates directly in charging the melt. During the course of charging he reports to the chief of the shift on changes that are occurring in the charging conditions and in the composition of the charge for a given grade of steel in order to introduce in time the necessary corrections. The heat conditions of the furnace during charging correspond to the speed of loading the materials into the furnace, thus assuring heating of each layer of charged material. During charging, the steelworker carefully checks that the charge does not become fused.

Charging is done in the following manner. When the first charging buggies with the charge arrive at the furnace the assistants check the size of the charging-box contents. They specially check with care, the hinged part of the charging-boxes in which there can be pieces of limestone, iron ore, etc. This examination makes it possible to eliminate delays in charging the round with the charging machine. After the examination the brigadeer gives the command to the charging-machine operator to start charging the round. On the carefully inspected, well-fettled hearth they charge 15-20 tons of light-weight clean scraps (tube trimmings) or clean shavings; after charging the first batch it is heated for 10-12 min and the 10 tons of limestone are charged. The limestone layer is well heated, the remaining scraps (mainly heavy weight) are charged, and at the end of the cast iron for steel is charged. V. I. Boldyrev observes the following rules during charging: the charge is loaded uniformly over the entire bottom and not more than three charging boxes are charged at each port. During charging the cover of the charging port is opened immediately before the approach of the charging machine with the box and closed immediately after the box leaves the furnace.

Heavy-weight scraps, poor casts, boilers, and bloom trimmings are charged near the center of the furnace. Heaping of the charge in front of the burners is not tolerated. A strict count of the materials being charged into the furnace is made, which prevents underloading or overloading the furnace. The furnace is kept as hot as possible during the charging: the roof temperature is not less than 1450°, the gas consumption is 1900-2100 m^3/hr, fuel oil is 700-800 kg/hr, air 32,000 m^3/hr. The thermal load corresponds to $25.2 \cdot 10^6$ kcal/hr. By using these operating methods, V. I. Boldyrev's brigade reduced the charging time by 10-15 min.

Melting

Melting occupies up to 40% of the entire time of the heat. V. I. Boldyrev shortened this process by correct and rapid fettling, charging, and also by accomplishing efficient slagging and heat conditions. The steelworker devotes considerable attention to the correct formation of the flame: he accelerates melting of the solid charge by using a sharp, brightly-shinning tongue of flame at the start of melting. At the end of melting, when slagging is completed and the capacity of the bath to absorb heat is reduced, Boldyrev elongates the flame by reducing the excess of air. He devotes special attention during the melting period to the slag-formation conditions. If a thick, inactive slag is formed in the furnace, then without waiting for complete fusion, bauxite is added and the consistency of the slag is reduced to normal. When liquid slag has formed in the furnace the workers add lime so that the slag will have a basicity of 1.6-2.0 at the moment of fusion. During the rapid formation of normal slag the process of the interaction between the metal and the slag being formed as the charge melts is accelerated and dephosphorization, decarbonization, and in part desulfurization are accelerated. The mounds of unfused charge are dislodged and separated with ramrods to accelerate melting. Blowing of compressed air also accelerates melting.

The heat conditions at the start of melting are held at the maximum: the consumption of gas is 2100 m^3/hr, fuel oil 800 kg/hr, air 32,000 m^3/hr, which corresponds to a thermal load of $25.2 \cdot 10^6$ kcal/hr. By the end of melting, the heat absorption by the bath is lowered and the steelworker reduces the delivery of fuel: the consumption of gas

is reduced to 1900 m^3/hr, air to 29,000 m^3/hr, fuel oil to 700 kg/hr, which corresponds to a thermal load of $21.5 \cdot 10^6$ kcal/hr. V. I. Boldyrev saves 30-40 min in melting.

Refinement and the Finish Boil

When fusion is completed a presampling is made of the carbon content for a rough determination of the amount of iron ore to add. At the instant of complete fusion, when the metal is already sufficiently heated and the slag has a normal fluidity, samples of the metal and slag are selected for chemical analysis. After this, the iron ore is added, the amount of which Boldyrev determines by taking into account the heat of the metal and the carbon content in the first and last sample. As a rule, the ore is added by a charging box at one receiver. Ten or fifteen minutes after the ore is charged the fuel supply is stopped and the slag is tapped in an amount such that the phosphorus content in the metal before deoxidation does not exceed 0.020%. After this, if needed, new slag is produced by adding lime or bauxite in an amount calculated so that at the instant of deoxidation a slag with a basicity of 2.6-3.0 is obtained. The timely and earliest possible reduction of basic and active slag is an imperative condition for normal refinement and for obtaining quality metal. Finish boiling continues for 40-60 min, thus assuring high speeds of burning out the carbon (0.005-0.008% per minute). A sufficiently active boil at a high metal temperature favors a vigorous mixing of the bath, its degassing, and thus high-quality metal is obtained. During the finish boil, V. I. Boldyrev slightly reduces the consumption of fuel: the gas to 1500 m^3/hr, fuel oil to 700 kg/hr, air to 25,000 m^3/hr, which corresponds to a thermal load of $18.8 \cdot 10^6$ kcal/hr. All additional materials are added under gas to assure the least loss of melter dust and the least possible construction of the regenerative checkers. Skill in correctly determining the temperature of the boiling bath, the activity and quality of the slag, and also in forcing the final melt – these are excellent features of the work of steelworker V. I. Boldyrev.

Deoxidation and Tapping

Taking into consideration the considerable effect that a timely and correct deoxidation and tapping has on the quality of steel and the output of suitable steel, V. I. Boldyrev prepares for these operations beforehand.

He selects samples of the metal and slag for chemical analysis to achieve a given carbon content, then he slowly adds the deoxidizers. Even before the start of deoxidation, at the end of the finish boil, V. I. Boldyrev prepares the entire furnace for tapping and gives orders to the assistants regarding the opening of the tap hole. After adding the deoxidizers and holding the bath for the required time the melt is tapped on command of the foreman and is finally deoxidized in the ladle with 45% ferrosilicon and aluminum.

ROLLING OF LIGHT-WEIGHT I-BEAMS, CHANNELS, AND ANGLES

Translated from Metallurg, No. 6, pp. 32-33, June, 1961

An interplant school for studying the experience of producing light-weight beams, channels, and angles at the Kuznetsk, Magnitogorsk, Nizhni Tagil Metallurgical Combines and the Petrovskii, Dzerzhinskii and "Azovstal'" Plants was held in September-October, 1960. In addition to this, the materials on the production of lightened sections at the Enakievo, Makeeva, Krivoi-Rog, Chelyabinsk, etc., Metallurgical Plants were examined.

Representatives of metallurgical plants, scientific research, planning and training institutes, and of the design bureaus participated in the work of the school.

In recent years it has become possible to improve considerably the technology of producing beams, channels, and angles as a result of new, highly mechanized rolling mills and by remodeling the old ones.

To roll light-weight sections at the plants required modernization of the existing equipment, the replacement of the main motors and individual working stands by more rigid ones, the introduction of all types of devices, lengthening of the reeling areas, an increase in the stock of rolls, an increase in the heating temperature, etc.

The Petrovskii Plant has mastered rolling of light-weight channels Nos. 20 and 22 on the structural mill and beams No. 10, channels Nos. 10 and 12, angles 75 × 75 × 7-8-9, 90 × 90 × 8-9, and 100 × 100 × 8-12 mm, shapes for automobile rims, blanks for automobile hinges, periodic billets for automobiles axles and for the crankshafts of the 550-mill.

New roll-pass designs were worked out for rolling the light-weight sections, whereby the sections of the starting billets were kept as before. The deformation in the passes was considerably increased, the temperature of heating the ingots prior to rolling was raised from 1150-1200°, the number of passes reduced from 9 to 7 (for channels Nos. 20 and 22).

The output was increased in the intermediate grooves when rolling light-weight channels: for channels Nos. 10 and 12 up to 30% and in the finishing grooves up to 15% with subsequent straightening of the bars on roller-straightening machines equipped with a special device – a pusher with a grooved upper expansible roller. This made it possible to increase the durability of the roll passes.

Measuring of the strip length within an accuracy to 100 mm was mechanized on the structural mill. The plant cost of production of the light-weight sections was reduced by 0.7-1.0% in comparison with the usual sections.

At the Dzerzhinskii Plant the light-weight sections are rolled on the medium-section 500-structural mill and on the 330- and 280-merchant mill. Rolling of No. 8 channels, angles 90 × 56 × 6-8 and 100 × 63 × 6-10 mm, shapes for the ZIL-150 automobile rims and the 6.0-20 with bevelled flanges, flat products for plowshares of steel 1490 and shapes for the back edge of plowshares has been mastered on the 500-mill.

A cutting groove with a blunt crest was used for rolling the No. 8 channel, thus providing a reliable centering of the rolled piece and the necessary depth of cutting the bar; two half-closed control passes were also used (out of seven forming passes) which made it possible to use a starting bar of ordinary size and to reduce the consumption of rolls per ton of output.

In addition, when rolling No. 8 channel a developed system is used for the roll-pass design with a 10% slope of the outer plane of the flanges in the finishing groove.

Of the two methods tested while mastering the rolling of unequal-leg light-weight angles, the preferred method was that in which the bisectrix of the bend of the flanges coincided with a vertical line and is not at an angle to it.

Light-weight No. 5 channels, equal-leg and unequal-leg angles are rolled on the 330-mill. An edging pass is used in the roll-pass design of all angles thus making it possible to regulate the width of the section. A cutting groove pinched along the bottom with a blunt cutting crest was used when mastering the No. 5 channel. This made

it possible to roll the channel in six passes and to center the bar nicely. For rolling the No. 5 channel it is planned to use a guiding device which will considerably ease the working conditions and increase the output of the mill.

Double-strand rolling was utilized when rolling equal- and unequal-leg angles on the 280-mill, and guides were used on the front and rear sides on both mills (330 and 280) when rolling angles, which considerably increased their output.

The technology developed at the "Azovstal'" Plant has made it possible to master the rolling of light-weight sections on the existing equipment. Light-weight beams and channels are rolled on the structural mill and the 650-mill, and angles only on the 650-mill.

Beams Nos. 24-55 are rolled on the structural mill in seven passes on the finishing line and in 7-9 passes on the 900-breakdown stand. A rectangular bloom 245 × 280-300 × 300 mm is used for beams Nos. 24-36 and a structural bloom for beams Nos. 45, 50, and 55. Large beams (No. 45 and higher) are rolled on the 800-rolling train in mated grooves with straight necks (the slope of the side walls of the grooves is to 2-5%), beams Nos. 36 and lower in grooves with curved webs (the slope of the side walls in the intermediate grooves is 8%).

Roll-pass designs with an increased delivery of the outside faces of the grooves were successfully used in the production of average size light-weight beams and channels; cast-iron grooved rolls and roller guides (discharge guides) were installed. All channels were rolled according to the method of developed flanges with a 20% slope of the side wall of the grooves in seven passes on the finishing line of the mill. Branding the finished rolled product in the production line and also delivery of specimens from the hot-cutting saws for checking were mechanized at the plant.

At the Kuznetsk Metallurgical Combine (KMC) light-weight I-beams, channels, and angles occupy a considerable portion of the rolled assortment. Thus, on the 500-mill they amount to 25% of the total production and 18% on the rail and structural mill.

Of special interest when rolling I-beams at the combine is the small lateral working of the metal in the closed flanges of the planishing passes and its absence in the finishing passes. A system of simultaneously mounted open and closed passes is used for rolling average and large beams on the structural mill instead of open passes; this makes it possible to obtain a shape with well-filled and relatively thin elements. In all groove designs for I-beams the grooves, with the exception of the finishing, have a developed form as a result of bending the collar. The magnitude of development is 6-8%.

Two systems exist at the combine for rolling angles: diagonal (a square billet is delivered diagonally to the first forming groove) and the usual system. When the billet is delivered diagonally to form the flanges of the angle, not the face of the billet enters but the corners least affected by surface defects, thus eliminating deburring and scarfing. With the exception of the finishing groove, all grooves have a open shape by developing the angle at the apex from 90 to 120-130°.

At the Magnitogorsk Metallurgical Combine (MMC) the lightened sections are rolled on mills with a zig-zag arrangement of stands 500, 300 No. 1 and No. 3 and the semicontinuous mill 250 No. 1. Since January, 1960, the combine has completely converted to rolling only the light-weight channels, beams, and angles. About 50 different sectional sizes have been mastered.

For rolling beams the MMC used open-flange passes with the delivery reaching 12% with a straight web (without bending). A semiclosed groove is used as the planishing groove in all passes when rolling channels, which somewhat eases the load on the finishing stands. The delivery of the roll-passes reaches 20%.

Angles are rolled with a variable angle for developing the legs.

In connection with rolling light-weight sections, the combine has automated the work of the manipulators on the merchant mills and on the 500-mill, in addition to this, transportation of the sections has been mechanized; removal of the trimmings from the hot-cutting saws was also mechanized on the 300 No. 1 and 2 and the 500 mills.

At the Nizhni Tagil Metallurgical Combine the light-weight sections are rolled on two mills – the 800-rail-and-structural mill and the 650-structural mill. The rolling of beams, channels, angles, and four special merchant shapes have been mastered: the 310 Z-beam, No. 13 channel, and shapes for railroad-car supports and tractor shoes; the assortment of light-weight flanged shapes continuously expands.

The average rolling temperature was raised by 20-30°. Light-weight beams are rolled at the combine according to the usual schedule for rolling ordinary beams (five to nine passes on the breakdown line and nine on the finishing line; seven passes are used for No. 45 beam). The open flanges in the intermediate beam groove have an outer slope of 10-15% (they usually have 4-7%) the slope of the closed flanges was kept at 2%.

The use of a universal stand considerably facilitated setting up the stands and rolling with negative tolerances; rolls consisting of a steel axle and a cast-iron banding were used.

Nine new passes were added for rolling the lightened beams: the delivery was increased from 8 to 15-40% with the right angle kept between the flange and the web.

The interior angle of the channels was reduced to 6% and that of the beams to 8%, instead of 10 and 12%, respectively. This helped to reduce flaws and also, it was possible to increase the width of the guide noses, thus reducing the number of broken guides and bound rolls.

Almost all the lightened sections are rolled from billets of lighter weight then the ordinary billets of the same sizes. The average productivity per shift calculated in pieces of rolled products from the light-weight sections is higher than when rolling the usual sections.

The school pointed out the great work which was carried out at the plants to improve the surface quality of billets while changing over to rolling light-weight sections; modernization of the equipment and the development of new grooving were also emphasized.

Also pointed out, were the advantages of beam passes having greater deliveries and especially those with a bend in the webs (KMC); the arrangement of the beam passes in the rolls of the three-high stands in the presence of thin shoulders (NTMC), the use of universal finishing stands for rolling beams (NTMC); the calculation of the spread in the intermediate grooves when rolling angles according to their middle lines and not according to their projections.

In addition, the school also noted that the actual hourly productivity in tons at most mills when rolling sections was reduced, but output expressed in meters was higher (the 650-mill at "Azovstal'" was 5-7% and up to 20% higher at certain plants).

The output of first grade products on most mills was at the former level, but on the 500-mill at the Enakievo and Petrovskii Plants it was somewhat higher; the consumption of rolls on a number of mills was doubled or more (KMC); the cost per running meter of lightened sections was lower than that for the corresponding ordinary sections by 7-20%.

The school recommended that a number of plants modernize the existing equipment, additionally equip mills rolling large beams with universal stands of modern design, expand the use of cast-iron rolls on the planishing stands of the mills, automate the operation of the main production lines of the mills (using NTMC experience) and broaden the use of television at the main sections of the mills (according to the experience at MMC), use at all plants the experience of the Kuznetsk Metallurgical Combine to remove water and scale from the rolled goods by steam-air blasting.

The school recommended, after the experience of the Petrovskii, Dzerzhinskii, and Saldinskii Plants, the use of finishing grooves with as increased delivery and additional straightening on the roller straightener when rolling channels.

It is recommended to use the experience of the NTMC for replacing the matched beam passes with passes arranged in a staggered order; to use the experience of the "Azovstal'" Plant for manufacturing light-weight guides.

The school considered it necessary to develop and introduce at all plants a single method for calculating the actual weight of sections; to automate measuring the length of the strips in the production flow (after the experience of the Petrovskii Plant) and also to use automatic facing of the guides when reconditioning the roll fittings.

In addition, the school suggested carrying out the following measures:

a) reexamine the construction of the large beams (No. 36 and higher) for the purpose of reducing the ratio of the thickness of the flange to the thickness of the web in order to eliminate waviness along the web;

b) to introduce into the standards an amendment permitting production of beams on mills equipped with universal stands within limits not exceeding the maximum heights provided for in the All-Union State Standard.

"FERROUS METALLURGY IN THE CZECHOSLOVAK SOCIALIST REPUBLIC"

Yu. L. Livovarov

Translated from Metallurg, No. 6, pp. 34-36, June, 1961

Czechoslovakia has a relatively large and technically well-developed metallurgical industry. About one third of the coke, pig-iron, and steel production of the European Socialist States is in the Czechoslovak Soviet Socialist Republic (CSSR).

The ferrous metallurgy of the Czech districts and of Slovakia have had a complex and tedious development process, from many haphazard undertakings to large and integrated operations.

In 1945, a new stage in the development of Czechoslovak metallurgy began; it was characterized by a simultaneous growth in production capacity and improvements in quality and geographic distribution (Table 1).

The high rate of industrial growth, and particularly of the machine-building industry which consumes 70% of the total ferrous-metal output, demands a constant increase in metal production. There is a simultaneous growth in the raw-material requirements for the ferrous metallurgy.

The supply of iron ore to the metallurgical concerns is at present a serious problem. Notwithstanding the constant growth of iron-ore mining in the country, domestic production satisfies only 30% of the requirements of the ferrous metallurgy. Approximately three-fifths of the iron ore mined (1.85 million tons in 1960) comes from Eastern Slovakia.

Since low-grade ores are predominant in Czechoslovakia and their utilization does not yield a very economical product, particular attention is being paid to the preparation of the blast-furnace change for smelting, to a higher degree of ore concentration, and highest possible metal recovery. A notion of the relative economy of the basic types of concentration processes for the Czechoslovak ores can be had from the data in Table 2.

Calculations show that, at present, pig-iron production from imported iron ore is 25% cheaper than from iron ball.

As a result of the appreciable growth in the beneficiation of domestic ores it is proposed that by 1965 all iron ores mined in the country will be fed to the blast-furnaces in the form of concentrates (with an iron content of not less than 53%).

In connection with the process intensification which is essential (together with a continued increase in the proportion of fines in the charge), sintering – the most important stage in the blast-furnace-charge preparation – is receiving particular attention. Accordingly, it is being planned to build 11 sintering plants during the third five-year plan. In 1965 the production of sinter will exceed 13 million tons (compared to 3.2 million in 1958) and its consumption per ton of pig iron produced will grow to 1700 kg (compared to 830 in 1958).

Because the ores smelted are largely acid, limestone is used predominantly as flux. In recent years there have been difficulties in supplying the metallurgical industry with sufficient amounts of high-quality limestone, and this in spite of the fact that the open-pit mines have been substantially enlarged and mechanized.

The Czechoslovak metallurgy is characterized by a wide gap between the production of steel and of pig-iron. Accordingly it is important that scrap be utilized rationally in the production of steel. Whilst in the period before the war, 70% of the Czechoslovak scrap needs were imported, in recent years (since 1952) ferrous metal scrap collection is satisfying the domestic needs (3.6 million tons in 1959).

Capacity increases have been achieved by enlarging and modernizing the old and building new installations; the latter are of the optimum size (considering Czechoslovak conditions). Great success was achieved in the conversion of the basic process stages in accordance with the demands of the fast-growing machine building and construc-

tion industries in Czechoslovakia. Accordingly, particular attention is being paid to the raising of output of quality steels (1.1 million tons in 1959) in the Czechoslovak steel industry.

TABLE 1. Main Indexes of the Growth of Ferrous Metallurgy (in million tons)

Year	Iron ore		Coke		Pig iron smelted	Steel smelted
	mined	imported	production	export		
1937	1.8	1.9	3.5	0.9	1.7	2.3
1948	1.4	1.8	4.3	1.1	1.6	2.6
1953	2.3	3.0	6.5	1.3	2.8	4.4
1959	3.0	6.4	7.9	1.2	4.2	6.1
1960	3.1	7.2	8.5	1.3	4.7	6.8
1965 Projected	4.5	10.0*	11.6	1.7	7.7	10.6

*Only from the Soviet Union.

The production of ferroalloys has been introduced and is rapidly growing. Ferroalloys were in the past almost totally imported. The work dealing with the introduction of production of high-quality steels in converters using an oxygen blast is progressing successfully. The first such converter has been put in operation in May, 1960 at the Kladno Plant (see figure). Based on productivity this converter is equivalent to about a 500-ton open-hearth furnace.

TABLE 2. Economics of the Basic Iron-Ore Concentrating Methods in Czechoslovakia

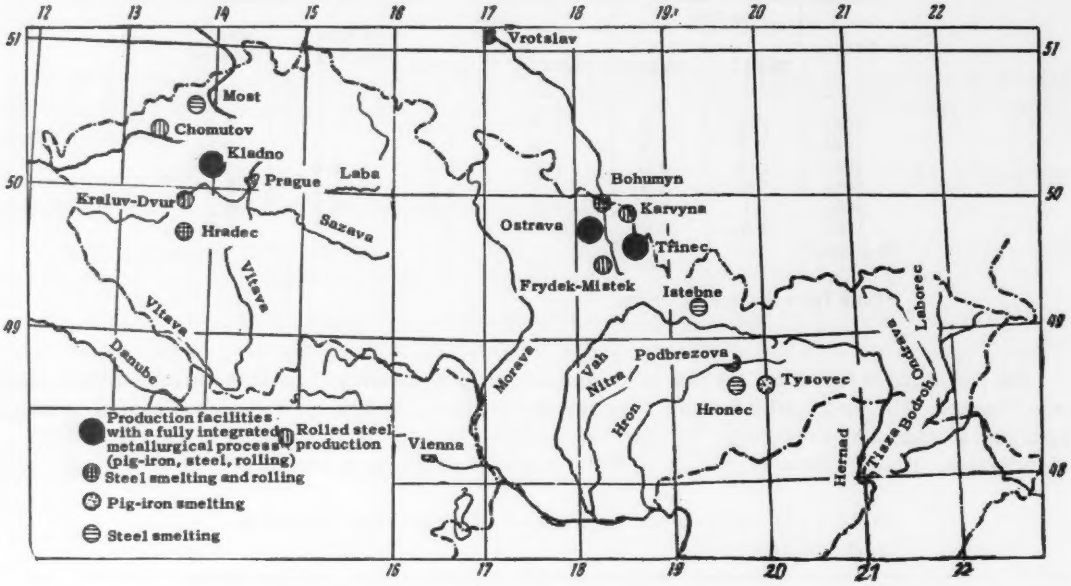
Concentrating method	Product	Treatment cost per ton (Krone)	Iron losses, %
Ball iron	Ball-iron process	100-130	12-18
Magnetizing roasting	Concentrated sinter	40-50	10-12
Sintering	Sinter	20-25	1-2

During the third five-year plan,oxygen -converter plants will be built at the Vitkovits Works (three converters with a capacity of 35 tons each) and at the Eastern Slovak Combine (three converters of 80 tons capacity each); the latter for the production of strip. This will bring about substantial changes in the makeup of steel-production facilities, as follows: the share of open-hearth production will decrease from 84% of the total in 1960 to 73% in 1965 as a result of the increase of the share that will be held by converters (bascially oxygen type) in 1965 to 13% and electric furnaces to 14%. Oxygen will be widely used also in the open-hearth and electric furnaces. During 1961-1965 all large steel plants will be equipped with oxygen facilities (at the moment, only the Vitkovits Works has an oxygen plant).

Most extensive equipment moderniziation has occurred in the rolling mills which up to recently were the most out of date process stage in the ferrous metallurgy (up to 1958 more than three-fifths of the rolling stands were obsolete in the technical sense and were installed before the first world war). During 1959-1960 eleven high-speed rolling mills were put into operation; these mills have an aggregate capacity of over 3 million tons of rolled stock per year.

Simultaneously the assortment of the rolled stock has improved. It has been planned for 1960-1965 to introduce production of special forms of sheet for the electrotechnical industry, cold strip, and more than 60 new steel shapes. The production of bent profiles and thin-walled welded pipe will increase substantially; the former will make possible a saving of 50% in comparison with conventional shapes.

More than 95% of the pig-iron and 80% of the steel is being presently produced at four metallurgical combines (three of them have a pig-iron and steel production capacity in excess of one million tons per year). Bringing into operation of the Eastern Slovak giant (four million ton annual capacity) will concentrate the production of steel in the large and technically progressive metallurgical concerns even further.



Location of the larger Metallurgical Concerns in the CSSR.

The main metallurgical region (the Ostrava Region) is characterized by large combines with a completely integrated metallurgical process and producing mainly common metal. Two of them are located in Ostrava itself. The old plant is in Vitkovitsa and the new one in Kunchitsa. The K. Gotwald Works in Vitkovitsa (founded in 1928) is one of the largest and most diversified metallurgical concerns in the country.

The country's second metallurgical center is Trinec. Here is located a combine which has blast-furnace capacity in excess of the capacity of the plant's steel shops. Pig-iron from Trinec is shipped to many parts of the country.

In addition to Ostrava and Trinec,notable are two steel smelting and rolling mill centers; these are Bohumyn and Frydek-Mistek. At Bohumyn, together with the production of steel (in recent years largely alloy steel), light rolled stock, and small castings, there is the largest wire producing facility in Czechoslovakia. In Fridek-Mistek, the largest sheet-rolling plant is located.

The second metallurgical region is the Central Czech region; it has basically only a regional significance. Its development is geared to supplying metal to the machine-building centers. Particular significance in the Czechoslovak metallurgy is enjoyed by Poldi Works (in the town of Kladno) which produces high quality steels. A duplex process is used (open-hearth – electric furnace) and also tool steel is being produced in low-frequency induction furnaces.

In addition to the two basic metallurgical regions, also notable are: the largest pipe mill in the country at Chomutov (about $\frac{1}{4}$ of all pipe production in Czechoslovakia); the steel smelting plant at Most (structural steel): in Slovakia, the old plant at Podberesove (about 0.2 million tons in 1960) at which the country's first continuous steel-casting plant was brought into production; and the new plants at Isgebno (ferroalloys production) and Grontse (electrometallurgy).

The development of the international socialist distribution of labor is, at this present time, having a marked effect on the geographic distribution of the Czechoslovak metallurgy. This distribution of labor is exemplified by the

increased flow of ore (together with fuel, metallurgical-plant equipment and other items) into Czechoslovakia, largely from the East (from the USSR and other socialist countries) and at the same time coke, rolled products, pipe (together with processed metal in the form of machines) moving in the opposite direction. This new factor has in a large measure influenced the shifting of the Czechoslovak metallurgy to the East during the third five-year plan.

In accordance with the decision of the XIth Congress of the Czechoslovak Communist Party (CCP) in 1958, the country's third metallurgical base will be built in Eastern Slovakia; it will be founded on the coal and iron-ore which will meet there. The center of this metallurgical base will be a metallurgical combine near the city of Koshitse. The construction of the third metallurgical base is an example of the solution of a tough economic problem whilst availing oneself of the conveniences offered by the development of the international, as well as interregional (within Czechoslovakia), socialist distribution of labor. The basic idea behind the third base of Czechoslovak metallurgy is in the complex treatment of Czechoslovak (Ostrava) coking coals and Soviet ore in such a region of the country, which is, on one hand, closest to the ore, plants, and markets, and on the other, located in Czechoslovakia's previously most backward region which has significant natural and human resources.

The Eastern Slovakia combine will be the largest and technically most advanced metallurgical concern among the European People's Democracies. Its projected annual capacity after completion of construction will be 4 million tons of steel. According to the plans, consumption of coke per ton of pig-iron will be less than 600 kg and the cost of a ton of pig-iron will be 500 Krone (instead of the average of 726 Krone at the other plants in the country in 1958). The combine is being constructed with the scientific and technical help of the USSR. The latter country will be supplying the necessary technical designs for the construction of large volume blast-furnaces and other plant equipment and will install a substantial part of the equipment, including two wide, high capacity rolling mills. In addition, Soviet specialists will be participating in the assembly of equipment.

Equipping the plant with large-capacity facilities to make thin plate and rolled stock of various shapes, will ensure not only the growth of metallurgy in terms of tonnage, but also will improve the relative capacity for various products, particularly for plate which has been in short supply and which was felt by the machine building industry. On the other hand, the erection of heavy metallurgy in Eastern Slovakia will lead to a rapid development of other branches of industry there, (such as machine building, coke-chemical, construction materials, etc.).

In order to satisfy the growing needs of the national economy for metals more economical use of metal assumes the first order of importance together with ensuring the growth of its production capacity (more economical use in lowering the weight of machinery as a result of new designs, use of cheaper shapes, plastics, etc.). Accordingly, long range plans envisage fundamental changes in the Czechoslovakia metallurgical production. These will be along the following lines:

a) Increasing the proportion of high-quality steel in the total steel tonnage (to 19% in 1965).

b) Increasing the share of plate in the total rolled-stock production (from 22% in 1960 to 30% in 1965). This will permit introducing as extensively as possible welding of components in machine building, production of most economical steel shapes, and increasing the production of welded pipe.

c) Increasing the proportion of steel pipe in the total steel production (not less than 0.9 million tons in 1965 – 27% of this welded pipe). The latter is necessary in order to supply the growing needs for pipe in machine building and farming in CSSR.

THE PROTECTION OF METAL WORKERS FROM RADIANT HEAT

A. A. Malykh

Sverdlovsk Institute for Labor Protection
Translated from Metallurg, No. 6, pp. 37-39, June, 1961

Combatting excessive heat – the chief production hazard in high-temperature shops – requires serious attention. Excessive heat, which creates abnormal meteorological conditions in high-temperature shops, makes working conditions more strenuous, gives rise to occupational diseases, and leads to a reduction in labor productivity.

Trade, technical, and planning institutes are developing units for continuous working of coal coking, steel production, heat-treatment, and the transport of molten and red-hot metal and slag. More and more frequently, television systems are being introduced into our factories together with remote control of individual plants and processes; the heat isolation and sealing-off of equipment for high-temperature technology is used as far as possible. The implementation of measures for combatting instances of heat evolution and radiation contributes to the healthfulness of working conditions. It must not be forgotten that the considerable growth in metal melting, and the intensification of production processes will lead to an increase in heat radiation.

In industry all sources of radiant heat are divided into moving and stationary, and the latter, in its turn, into open and covered. It is most difficult to develop protective installations against moving sources of radiant heat, such as hot ingots, sheets moving on roll-conveyers, molten metal, and slag. Only mechanization of the work and remote control are capable of normalizing working conditions in these cases. A sharp limitation of heat evolution is achieved by improving the thermal isolation of equipment and pipelines by the use, where this is possible, of light-weight refractories, by painting furnace equipment in bright colors, and by reducing the time during which doors and observation windows are uncovered. Hot metal and slag should be more rapidly transported beyond the shop boundaries. The correct organization of so-called aeration (of natural air-volumes); is very important that is, the installation of air-tight connecting pieces and wind-repelling screens and to the mechanization of the opening of apertures. In using these measures, the different temperature conditions in summer, transitional, and winter periods must be taken into account, as well as the features of the climatic region in which the factory is situated.

Water-spraying supplements aeration and lowers the temperature of the incoming air because of the latent heat of evaporation of the very small drops of water. Moisture falling on the heated surface of the floor and equipment counteracts secondary sources of heat evolution. For water-spraying, pneumatic, hydraulic, and mechanical sprays are generally used. Pneumatic water atomizers, centrifugal water-sprayers and industrial pulverizers and the supplying of water to rapidly rotating disks – all these ensure the proper breaking-up of the water.

Screening-protection devices often have general purpose importance in protecting workers not only from radiant heat, but also from sparks and splashes of molten metal, slag, and scale flying off. Screens and shields most frequently intercept radiant energy and absorb it, more rarely – they reflect it to the light source; however, there are installations with mixed action.

Metallurgists are well acquainted with water-cooled frames used in high-temperature furnaces, base girders, and doors; the last-named is sometimes lined with refractory or insulating brick. The use of water-cooled doors in open-hearth furnaces reduces the value of radiant energy opposite the window openings by a factor of 3-8. An improvement in their quality and an increase in their life has been connected with the standardization and centralization of the preparation of cooled elements; this has made it possible to reduce the number of hot repairs carried out on the front furnace wall.

In high-temperature shops, metallic, asbestos, and aluminum opaque screens are widely used. For hot repairs, cast temporary walls, which are removable and lined with refractory brick, are set up in the furnace by crane mechanisms. Of the semitransparent screens used, one can name chain screens, and thick metal mashes, including also those flooded with freely draining water.

As transparent protective devices, aqueous screens, tank screens (filled with distilled water), and organic glass are coming into use, where they are required under the industrial conditions.

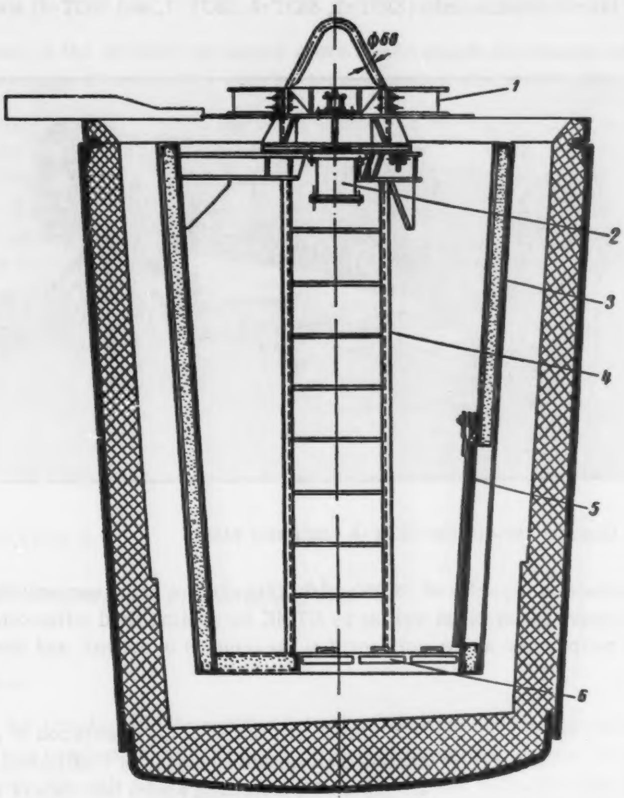


Fig. 1. Chamber for repairing hot steel-pouring ladles. 1) Cross-arm; 2) bearing; 3) body of the chamber; 4) ladder; 5) doors of the chamber; 6) lower hatch cover.

In the list of protective devices, one must not forget heat-protective chambers – caissons and cabins, used in repairing steel-pouring ladles and heating pits. An improved revolvable heat-protective chamber for work in large-capacity steel-pouring ladles, designed by the Sverdlovsk Institute for Labor Protection, has been successfully tested in the open-hearth shop of the Nizhni Tagil Metallurgical Combine (NTMK). It consists of a welded, hollow, metal cone open at the top with double walls and a double floor; the space between them is filled with slag-wool (Fig. 1). The openings in the wall and floor of the chamber may be covered and may be used in assembling connecting pieces and sockets and repairing the lining of the bottom of the ladle.

Until recently, work at the stationary steel-pouring channel was labor-consuming and injurious. The combined use of encased water-cooled side plates (Verkh-Iset and Ufaleisk Factories), movable staging for dismantling the channel (Revdinsk Metal Mesh and Metallurgical Factory), multigripping devices for ingot-molds and ingots (Lys'va Factory), together with air supply by central ventilating systems through the side of the channel, has considerably normalized working conditions.

In rolling shops, cast and welded water-cooled plates are being used, which make it possible to reduce the floor temperature by 30-40°C.

A large role in combatting radiant heat is played by air currents, which contribute to a considerable increase in labor productivity, especially in heavy physical work and during summer weather. The currents are of two types. In one instance, outside air treated by suitable means is supplied; in this case, central installations are used with delivery purification chambers and a system of insulated air-pipelines and branch-pipes for delivering the air. In the other instance, with the help of stationary and movable centrifugal or axial ventilators, somewhat moistened shop air is circulated. In metallurgical factories, Stary Oskol Factory aerators PAM-24 (SIOT-6) and the typical Sverdlovsk Institute for Labor Protection fan-ventilation units (SIOT-3, SIOT-5, SIOT-7, and SIOT-8) are widely used.

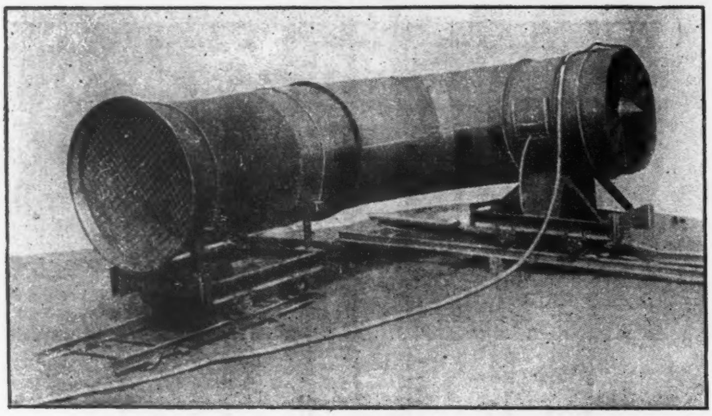


Fig. 2. General view of the SIOT-8 ventilator plant.

SIOT-8 units, with a production capacity of 28,000 m^3/hr (Fig. 2), are being successfully used by the Vogdanovichsk and Sukholosk refractory factories, as well as by NTMK for cooling fired refractories in circular furnaces in refractory production. Air temperature at the work position has returned to normal, and the productivity of furnaces and workers has risen.

Air conditioners for the ventilation of closed cabs, on bridge cranes, the centralized supply of conditioned external air along air-pipes with impelling blades into cabs of the semiclosed type, and the treatment of shop air with showers (Magnitogorsk Metallurgical Combine) have considerably eased the work of machine technicians.

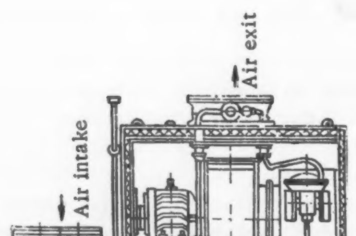


Fig. 3. Type KD-25 and KD-26 conditioners.

Working conditions during repairs to reheating and melting plants have always been very heavy. Now, during average repairs on open-hearth furnaces, water and air, supplied by SIOT-7 units, are widely used for cooling the lining. By intensely cooling the regenerator chambers of open-hearth furnaces at the Nizhni Tagil Metallurgical Combine for 8-10 hours, it was possible to reduce considerably the air temperature and radiant heat level, especially while cutting out the regenerator brick-work, even though the total repair time remained unaltered. Up to 9 tons of water and 100,000 m^3 of air were delivered in one hour into one regenerator chamber of a large capacity furnace. The efficiency of cooling the lining in this way can be increased by intensifying the draft in the flue.

Air conditioning is finding ever-increasing use in the metallurgical industry (at machine-control panels, in the cabs of heavy cranes, and at other working places in rooms of small volume). To accomplish the necessary cooling, special refrigeration installations are constructed to use waste heat. For the ventilation of control

positions, control and measuring-instrument rooms, and rest rooms, type KD-25, and KD-26 conditioners are used with surface heat-exchangers (Fig. 3) and SKK-11 crane air conditioners.

Normalization of working conditions in high-temperature shops is impossible without providing the workers with individual safeguards, such as appropriate general-purpose overalls, which protect not only against radiant heat, but also against molten and red-hot metal, dust, and the possibility of injury. Heat-resistant overalls are used, and protective footwear, various light filters, screens, nets and spectacles have been developed for the different production processes.

The combined used of the methods mentioned above should ensure the creation of the necessary meteorological conditions at working positions in conformity with the requirements of the State health norms.

Together with such practices, methods are being worked out to counteract the consequences of heat exposure: these are directed to the more rapid restoration of the body functions of workers undergoing exposure to radiant heat or working at a high air-temperature. The following have a bearing on this: the schedule of work and rest during the shift; well-organized rest locations for the workers; a logical drinking schedule with the use of salted, cooled, and aerated water and albumin-vitamin drinks; water-procedures (semishowerbath water installations); the administration of first aid in cases of overheating.

In conclusion, it should be noted that what has been done up to now to protect metal workers from radiant heat does not give reason to slacken off. There is still much to do to ease and normalize working conditions in high-temperature shops.

FROM THE NEWSPAPERS

Translated from Metallurg, No. 6, p. 39, June, 1961

Sheet From Powder

Collaborators in the Metalloceramic and Special Alloys Institute have developed an experimental production mill for rolling sheet from powders of various metals, namely, iron, nickel, copper, tungsten, etc. The metal powder is compressed between the rolls and, already in sheet form 250 mm wide, proceeds into a furnace for sintering. The thickness of sheet obtained can be regulated in the range 0.1 to 2.5 mm.

Instead of 6 Minutes – 13 Seconds

In the electric steel-melting shop of the Zlatoust Metallurgical Factory, a pneumatic dispatch system is ready for service to convey metal samples to chemical analysis.

At the moment, conveying each sample takes up to 5-6 minutes of working time: and for each melt 6-8 samples are needed. With the pneumatic dispatch system in service, losses of working time no longer arise. The pneumatic dispatch system will deliver the sample for analysis in 12-13 seconds.

Rapid Cutting of Stainless Steel

At the All-Union Scientific Research Institute for Electric Welding Equipment, a unique industrial installation "UGER-2" for cutting metals has successfully undergone tests.

The machine can cut stainless steel 100 mm thick with an average speed of around 10 m/hr.

New Welding

The E. O. Paton Institute of Electric Welding has created a new machine for the modernization of the tube-welding plant at the Il'ich Factory in Zhdanov.

On this machine, practical experience is being gained on the output of 630 mm diameter tubes for high-pressure gas and petroleum mains. The tubes are prepared from steel sheet 1 m wide.

A special installation turns the sheet into a spiral, and the new machine now welds the spiral not only from the outside, but also from the inside. Tubes with spiral welds are obtained with the correct cylindrical shape. This eliminates the need for equipment to finish them to size.

Smallest in the Country

Workers in the Faculty of the Metallurgy of Ferrous Metals at the Dneprodzerzhinsk Factory technical college have constructed a blast-furnace which is the smallest in its dimensions. Its effective volume is 0.065 m^3, and the weight of a single melt, 100 kg. The furnace is equipped with complete instrumentation, which makes it possible to measure the temperature in the furnace and in the hearth, to take material and gas samples and to carry out investigations. Control of the melting process is carried out with help of automatic apparatus.

THE CONSTRUCTION AND REPAIR OF INDUSTRIAL FURNACES

(A SURVEY OF BOOKS PUBLISHED IN 1959 AND 1960)

A. Lekhtik

Translated from Metallurg, No. 6, p. 40, June, 1961

Engineering and technical workers engaged in the construction and repair of industrial furnaces have to solve very varied technical problems in the course of their work. However, until recently, in the pages of the technical journals, problems of construction and repair only of individual units were chiefly discussed, and in books, chiefly refractory work. Insufficient reference literature had been published. Material on the whole complex of modern organization and technical work up till now had not been summarized and published.

In 1959 and 1960 books were published which filled the considerable gap in this field. Of these, the following should be noted.

V. I. Bel'skii, A. P. Gora, N. G. Molchanov, and A. V. Chernov. Construction and Repair of Metallurgical Furnaces, Moscow. Metallurgizdat, 1959, 448 pages.

In this book, in keeping with the program of the course in metallurgical higher educational institutions, entitled "Construction and repair of metallurgical furnaces," there are described the organization and mechanization of work in the repair of the metal structures and equipment, and of the refractory lining of the main types of industrial furnace. A description is also presented of work in the repair of furnaces and in the erection and repair of blast tubes, and the characteristics of constructional materials and mechanisms used in this, are also given. In the book light is thrown on the problems of the initial heating of furnaces and bringing them into use, and also on the costs of construction and repair.

N. I. Lukashkin. Construction of Blast-Furnace Shops. Moscow, Gosstroiizdat, 1959, 615 pages.

An account is given in this book of the whole complex of problems in the structure of modern blast-furnace shops. The construction of blast-furnaces and of all the units entering into the composition of the blast-furnace shop is described. A detailed account is given of production problems in excavation and reinforced concrete work. A description is also given of the erection of the steel structures, of the cooling equipment and cooling system, of the production of the refractory lining, and also concrete examples of the construction and reconstruction of blast-furnaces by the push-up method. The book is richly illustrated with photographs and examples from blast-furnace shop construction practice, and may serve as a guiding textbook for engineer-technical workers engaged on the construction and planning of blast-furnace complexes.

A. P. Gora and A. A. Zil'berman. Blast-Furnace Repairs. Moscow, Metallurgizdat, 1960, 543 pages.

The authors were faced with the problem of summarizing and systematizing many years advanced experience of carrying out blast-furnace repairs gathered by the specialized groups "Uraldomnaremont" and "Yuzhdomnaremont" and by metallurgical factories. In the book light is thrown on modern organization of rapid blast-furnace repairs. The technology of mechanical erection, refractory and other work executed by advanced industrial methods during repair is described. A detailed account is given of organizational and technical measures taken in the period of preparing for and carrying out the repair. In the book light is thrown on the problems of blast-furnace reconstruction by

the push-up method, and examples are given of a number of unique repairs which have been carried out in recent years. The book is a valuable practical textbook for engineering and technical personnel connected with the repair and construction of blast-furnaces, and it is also recommended for students of technical high schools, in studying corresponding disciplines.

Soviet Journals Available in Cover-to-Cover Translation

ABBREVIATION	RUSSIAN TITLE		TITLE OF TRANSLATION	PUBLISHER	TRANSLATION BEGAN Vol.	Issue	Year
AÉ	Atomnaya énergiya		Soviet Journal of Atomic Energy	Consultants Bureau	1	1	1956
Akust. zh.	Akusticheskii zhurnal		Soviet Physics – Acoustics	American Institute of Physics	1	1	1955
	Antibiotiki		Antibiotics	Consultants Bureau	4	1	1959
Astr(on). zh(urn).	Astronomicheskii zhurnal		Soviet Astronomy—AJ	American Institute of Physics	34	1	1957
Avto(mat). svarka	Avtomaticheskaya svarka		Automatic Welding	British Welding Research Association (London)		1	1959
	Avtomatika i Telemekhanika		Automation and Remote Control	Instrument Society of America	27	1	1956
	Biofizika		Biophysics	National Institutes of Health*		1	1957
	Biokhimiya		Biochemistry	Consultants Bureau	21	1	1956
Byull. éksp(erim). biol. i med.	Byulleten' éksperimental'noi biologii i meditsiny		Bulletin of Experimental Biology and Medicine	Consultants Bureau	41	1	1959
DAN (SSSR) Dokl(ady) AN SSSR	Doklady Akademii Nauk SSSR		The translation of this journal is published in sections, as follows:				
		Life Sciences	Doklady Biochemistry Section	American Institute of Biological Sciences	106	1	1956
		Life Sciences	Doklady Biological Sciences Sections (Includes: Anatomy, biophysics, cytology, ecology, embryology, endocrinology, evolutionary morphology, genetics, histology, hydrobiology microbiology, morphology, parasitology, physiology, zoology sections)	American Institute of Biological Sciences	112	1	1957
		Life Sciences	Doklady Botanical Sciences Sections (Includes: Botany, phytopathology, plant anatomy, plant ecology, plant embryology, plant physiology, plant morphology sections)	American Institute of Biological Sciences	112	1	1957
		Chemical Sciences	Proceedings of the Academy of Sciences of the USSR, Section: Chemical Technology	Consultants Bureau	106	1	1956
		Chemical Sciences	Proceedings of the Academy of Sciences of the USSR, Section: Chemistry	Consultants Bureau	106	1	1956
		Chemical Sciences	Proceedings of the Academy of Sciences of the USSR, Section: Physical Chemistry	Consultants Bureau	112	1	1957
		Earth Sciences	Doklady Earth Sciences Sections (Includes: Geochemistry, geology, geophysics, hydrogeology, mineralogy, paleontology, petrography, permafrost sections)	American Geological Institute	124	1	1959
		Earth Sciences	Proceedings of the Academy of Sciences of the USSR, Section: Geochemistry	Consultants Bureau	106-123	1 6	1957-1958
		Earth Sciences	Proceedings of the Academy of Sciences of the USSR, Sections: Geology	Consultants Bureau	106-123	1 6	1957-1958
		Mathematics	Doklady Soviet Mathematics	The American Mathematics Society	131	1	1961
		Physics	Soviet Physics—Doklady (Includes: Aerodynamics, astronomy, crystallography, cybernetics and control theory, electrical engineering, energetics, fluid mechanics, heat engineering, hydraulics, mathematical physics, mechanics, physics, technical physics, theory of elasticity sections)	American Institute of Physics	106	1	1956
		Physics	Proceedings of the Academy of Sciences of the USSR, Applied Physics Sections (does not include mathematical physics or physics sections)	Consultants Bureau	106-117	1	1956-1957
Derevoobrabat. prom-st'.	Derevoobrabatyvayushchaya promyshlennost'		Wood Processing Industry	Timber Development Association (London)		9	1959
	Élecktrosvyaz		Telecommunications	Massachusetts Institute of Technology*		1	1957
Éntom(ol). oboz(renie)	Éntomologicheskoe obozrenie		Entomological Review	American Institute of Biological Sciences	38	1	1959
Farmakol. (i) toksikol(ogiya)	Farmakologiya i toksikologiya		Pharmacology and Toxicology	Consultants Bureau	20	1	1957
FMM	Fizika metallov i metallovedenie		Physics of Metals and Metallography	Acta Metallurgica*	5	1	1957
Fiziol. zhurn. SSSR (im. Sechenova)	Fiziologicheskii zhurnal im. I. M. Sechenova		Sechenov Physiological Journal USSR	National Institutes of Health*		1	1957
Fiziol(ogiya) rast.	Fiziologiya rastenii		Plant Physiology	American Institute of Biological Sciences	4	1	1957
	Geokhimiya		Geochemistry	The Geochemical Society		1	1958
FTT	Fizika tverdogo tela		Soviet Physics—Solid State	American Institute of Physics	1	1	1959
Izmerit. tekh(nika)	Izmeritel'naya tekhnika		Measurement Techniques	Instrument Society of America		1	1959
Izv. AN SSSR, O(td). Kh(im). N(auk)	Izvestiya Akademii Nauk SSSR: Otdelenie khimicheskikh nauk		Bulletin of the Academy of Sciences of the USSR: Division of Chemical Sciences	Consultants Bureau		1	1952

continued

Izv. AN SSSR, O(td). T(ekhn). N(auk): Met(all). i top.	(see Met. i top.)					
Izv. AN SSSR Ser. fiz(ich).	Izvestiya Akademii Nauk SSSR: Seriya fizicheskaya	Bulletin of the Academy of Sciences of the USSR: Physical Series	Columbia Technical Translations		1	1954
Izv. AN SSSR Ser. geofiz.	Izvestiya Akademii Nauk SSSR: Seriya geofizicheskaya	Bulletin (Izvestiya) of the Academy of Sciences USSR: Geophysics Series	American Geophysical Union		1	1954
Izv. AN SSSR Ser. geol.	Izvestiya Akademii Nauk SSSR: Seriya geologicheskaya	Izvestiya of the Academy of Sciences of the USSR: Geologic Series	American Geological Institute		1	1958
Kauch. i rez.	Kauchuk i rezina	Soviet Rubber Technology	Research Association of British Rubber Manufacturers	18	1	1959
	Kinetika i kataliz	Kinetics and Catalysis	Consultants Bureau	1	3	1960
	Koks i khimiya	Coke and Chemistry USSR	Coal Tar Research Association (Leeds, England)		1	1958
Kolloidn. zh(urn).	Kolloidnyi zhurnal	Colloid Journal	Consultants Bureau	14	1	1952
	Kristallografiya	Soviet Physics – Crystallography	American Institute of Physics	2	1	1957
Metalov. i term. obrabot. metal.	Metallovedenie i termicheskaya obrabotka metallov	Metal Science and Heat Treatment of Metals	Acta Metallurgica	6	1	1958
	Metallurg	Metallurgist	Acta Metallurgica		1	1957
Met. i top.	Metallurgiya i topliva	Russian Metallurgy and Fuels	Eagle Technical Publications		1	1960
Mikrobiol.	Mikrobiologiya	Microbiology	American Institute of Biological Sciences	26	1	1957
OS	Optika i spektroskopiya	Optics and Spectroscopy	American Institute of Physics		6	1959
	Pochvovedenie	Soviet Soil Science	American Institute of Biological Sciences		1	1958
	Priborostroenie	Instrument Construction	British Scientific Instrument Research Association		1	1959
Pribory i tekhn. éks(perimenta)	Pribory i tekhnika éksperimenta	Instruments and Experimental Techniques	Instrument Society of America		1	1957
Prikl. matem. i mekh.	Prikladnaya matematika i mekhanika	Applied Mathematics and Mechanics	American Society of Mechanical Engineers		1	1958
PTÉ	(see Pribory i tekhn. éks.)					
	Problemy Severa	Problems of the North	National Research Council of Canada			
Radiotekh.	Radiotekhnika	Radio Engineering	Massachusetts Institute of Technology*	12	1	1957
Radiotekh. i élektronika	Radiotekhnika i élektronika	Radio Engineering and Electronics	Massachusetts Institute of Technology*	2	1	1957
	Stanki i instrument	Machines and Tooling	Production Engineering Research Assoc.		1	1959
	Stal'	Stal (In English)	Iron and Steel Institute		1	1959
Stek. i keram.	Steklo i keramika	Glass and Ceramics	Consultants Bureau	13	1	1956
Svaroch. proiz-vo	Svarochnoe proizvodstvo	Welding Production	British Welding Research Association		4	1959
Teor. veroyat. i prim.	Teoriya veroyatnostei i ee primenenie	Theory of Probability and Its Applications	Society for Industrial and Applied Mathematics		1	1956
Tsvet. Metally	Tsvetnye metally	Nonferrous Metals	Primary Sources		1	1960
UFN	Uspekhi fizicheskikh Nauk	Soviet Physics – Uspekhi (partial translation)	American Institute of Physics	66	1	1958
UKh	Uspekhi khimii	Russian Chemical Reviews	The Chemical Society (London)		1	1960
UMN	Uspekhi matematicheskikh nauk	Russian Mathematical Surveys	London Mathematical Society	15	1	1960
Usp. fiz. nauk	(see UFN)					
Usp. khim(ii)	(see UKh)					
Usp. matem. nauk	(see UMN)					
Usp. sovr. biol.	Uspekhi sovremennoi biologii	Russian Review of Biology	Oliver and Boyd		48	1959
Vest. mashinostroeniya	Vestnik mashinostroeniya	Russian Engineering Journal	Production Engineering Research Assoc.		4	1959
Vop. gem. i per. krovi	Voprosy gematologii i perelivaniya krovi	Problems of Hematology and Blood Transfusion	National Institutes of Health*		1	1957
Vop. onk.	Voprosy onkologii	Problems of Oncology	National Institutes of Health*		1	1957
Vop. virusol.	Voprosy virusologii	Problems of Virology	National Institutes of Health*		1	1957
Zav(odsk). lab(oratoriya)	Zavodskaya laboratoriya	Industrial Laboratory	Instrument Society of America	25	1	1959
ZhAKh Zh. anal(it). khimii	Zhurnal analiticheskoi khimii	Journal of Analytical Chemistry USSR	Consultants Bureau	7	1	1952
ZhETF Zh. éksperim. i teor. fiz.	Zhurnal éksperimental'noi i theoreticheskoi fiziki	Soviet Physics–JETP	American Institute of Physics	28	1	1955
ZhFKh Zh. fiz. khimii	Zhurnal fizicheskoi khimii	Russian Journal of Physical Chemistry	The Chemical Society (London)		7	1959
ZhMÉI Zh(urn). mikrobiol. épidemiol. i immunobiol.	Zhurnal mikrobiologii, épidemiologii i immunobiologii	Journal of Microbiology, Epidemiology and Immunobiology	National Institutes of Health*		1	1957
ZhNKh Zh(urn). neorgan(ich). khim(ii)	Zhurnal neorganicheskoi khimii	The Russian Journal of Inorganic Chemistry	The Chemical Society (London)		1	1959
ZhOKh Zh(urn). obshch(ei) khimii	Zhurnal obshchei khimii	Journal of General Chemistry USSR	Consultants Bureau	19	1	1949
ZhPKh Zh(urn). prikl. khimii	Zhurnal prikladnoi khimii	Journal of Applied Chemistry USSR	Consultants Bureau	23	1	1950
ZhSKh Zh(urn). strukt. khimii	Zhurnal strukturnoi khimii	Journal of Structural Chemistry	Consultants Bureau	1	1	1960
ZhTF Zh(urn). tekhn. fiz.	Zhurnal teknicheskoi fiziki	Soviet Physics–Technical Physics	American Institute of Physics	26	1	1956
Zh(urn). vyssh. nervn. deyat. (im. Pavlova)	Zhurnal vysshei nervnoi deyatel'nosti (im. I. P. Pavlova)	Pavlov Journal of Higher Nervous Activity	National Institutes of Health*		1	1958

*Sponsoring organization. Translation through 1960 issues is a publication of Pergamon Press.

SIGNIFICANCE OF ABBREVIATIONS MOST FREQUENTLY ENCOUNTERED IN SOVIET PERIODICALS

FIAN	Phys. Inst. Acad. Sci. USSR.
GDI	Water Power Inst.
GITI	State Sci.-Tech. Press
GITTL	State Tech. and Theor. Lit. Press
GONTI	State United Sci.-Tech. Press
Gosénergoizdat	State Power Engr. Press
Goskhimizdat	State Chem. Press
GOST	All-Union State Standard
GTTI	State Tech. and Theor. Lit. Press
IL	Foreign Lit. Press
ISN (Izd. Sov. Nauk)	Soviet Science Press
Izd. AN SSSR	Acad. Sci. USSR Press
Izd. MGU	Moscow State Univ. Press
LÉIIZhT	Leningrad Power Inst. of Railroad Engineering
LÉT	Leningrad Elec. Engr. School
LÉTI	Leningrad Electrotechnical Inst.
LÉTIIZhT	Leningrad Electrical Engineering Research Inst. of Railroad Engr.
Mashgiz	State Sci.-Tech. Press for Machine Construction Lit.
MÉP	Ministry of Electrotechnical Industry
MÉS	Ministry of Electrical Power Plants
MÉSÉP	Ministry of Electrical Power Plants and the Electrical Industry
MGU	Moscow State Univ.
MKhTi	Moscow Inst. Chem. Tech.
MOPI	Moscow Regional Pedagogical Inst.
MSP	Ministry of Industrial Construction
NII ZVUKSZAPIOI	Scientific Research Inst. of Sound Recording
NIKFI	Sci. Inst. of Modern Motion Picture Photography
ONTI	United Sci.-Tech. Press
OTI	Division of Technical Information
OTN	Div. Tech. Sci.
Stroiizdat	Construction Press
TOÉ	Association of Power Engineers
TsKTI	Central Research Inst. for Boilers and Turbines
TsNIÉL	Central Scientific Research Elec. Engr. Lab.
TsNIÉL-MÉS	Central Scientific Research Elec. Engr. Lab.-Ministry of Electric Power Plants
TsVTI	Central Office of Economic Information
UF	Ural Branch
VIÉSKh	All-Union Inst. of Rural Elec. Power Stations
VNIIM	All-Union Scientific Research Inst. of Meteorology
VNIIZhDT	All-Union Scientific Research Inst. of Railroad Engineering
VTI	All-Union Thermotech. Inst.
VZÉI	All-Union Power Correspondence Inst.

Note: Abbreviations not on this list and not explained in the translation have been transliterated, no further information about their significance being available to us - Publisher.